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OF THE

TEA RESEARCH INSTITUTE

OF CEYLON

THE TEA RESEARCH INSTITUTE,
St. Coombs, Talawakelle,
Ceylon.

The Tea Research Institute of Ceylon.

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NOTE

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ADDRESS BY HIS EXCELLENCY THE RIGHT HONOURABLE LORD SOULBURY,

G.C.M.G., O.B.E., M.C.,

GOVERNOR GENERAL OF CEYLON.

This very important Conference, which I am privileged to attend, is concerned with a subject of fundamental and vital importance

N.B.

Parts II & III of Volume XXI of the Tea Quarterly for 1950 will follow this number shortly.

paid to the progress of agriculture in other parts of the world.

For it is a fact that though, generally speaking, mechanization has increased the output of agricultural produce per man hour, the increase in yields per acre has been quite disproportionate. Soil has been exploited and agricultural mining operations have reduced fertile areas to dust bowls. Scarred and gullied lands have replaced fertile forests, where man's greed for wealth and quick returns has led him to clear and cultivate steep lands for catch crops.

With that picture in mind, it is a real pleasure to come into the midst of well-organised and well-managed tea estates and to address representatives of an agricultural industry which for about a century has cultivated steep hillsides under conditions of heavy rainfall and has maintained the fertility of the soil entrusted to it.

Therefore, when I read of extensive soil erosion in other parts of the world and the wasteful methods of cultivation practised in many countries, I judge your achievement to be of no mean order.

I would like warmly to congratulate you as representatives of this industry, upon the invaluable contribution which your efforts have made to the prosperity of this Island and to the welfare of its inhabitants.

It has not been the easy effortless job that people unfamiliar with the history of your tea industry might imagine. Your success has been hardly earned and richly deserved, and your progress has been the result of unremitting care and attention to your work.

In the later years of last century many of your estates were planted in tea, under circumstances of great difficulty, when disease had in a few years wiped out the original plantations of coffee and left in their place bare hillsides and financial ruin.

Confronted with that calamity, it must have taken very great courage and determination to build up the tea industry. And it was indeed fortunate that tea was chosen to replace coffee, for apart from cinchona, I know of no other crop which has been or could be grown with any success on the steep hillsides of your up-country districts. Synthetic anti-malarial drugs are displacing quinine and synthetic rubber threatens the future of the rubber industry. But synthetic tea has not yet been invented and even if it were, I don't think that your principal customers, the British people, would ever exchange the synthetic substitute for their favourite beverage.

And yet the shadow of disease has again crept over the plantations in these hills and I have gathered from conversations with planters during the past months that many of you have grave anxieties as to the effect of repeated attacks of blister blight.

Happily the progressive spirit of the tea industry and the foresight of your Prime Minister, when he was Minister of Agriculture, have provided the plantations of Ceylon with well equipped Research Institutes, ready and able to give advice and help in emergencies of this nature.

Thanks to the kindness of Mr. Lamb and his staff, I have been able to learn a little of the problem, and of the activities of the officers of the Tea Research Institute in combating the blight. I understand that control of the disease is now possible and practicable, but I fully appreciate that control measures will add greatly to your responsibilities and your expenses.

Research can only lead the way and give guidance; the successful application of control measures will depend upon your energy and initiative. It is my fervent hope that you will be successful, for the prosperity of the people of this Island depends upon your efforts.

We must all bear in mind that, although the tea industry is enjoying the prosperity that results from high prices, it would be most unwise to expect those prices to last for ever. There is, as we all know from experience, the possibility and indeed the probability of lower prices and active competition from other producers.

In your hands the tea industry of Ceylon has enjoyed for many years a reputation for the production of high quality tea, which has always demanded a premium in the world's markets and, even during times of slump, has enabled you to work your estates with a small margin of profit.

It is, therefore, essential that you maintain your reputation for quality. But that alone will not be sufficient. Your agriculture must be progressive and every effort made to increase your yields per acre.

I have obtained some figures comparing the output and yield of tea for 1939 with 1949. In 1939 the acreage was about five hundred and fifty-three thousand acres and the total yield two hundred and ninety-six million pounds. Ten years later the acreage was five hundred and fifty-five thousand acres and the total yield two hundred and ninety-eight million pounds. So the decade showed practically no increase but, at any rate, your output and yield have not, as in the case of other agricultural industries in various parts of the world, receded. Nevertheless, I feel sure you will agree that there is ample scope for advance, and I understand that many of you have been searching for high yielding types of tea and that, in some cases, a considerable degree of success has already been achieved.

Blister blight resisting plants, especially plants combining resistance with high yielding properties, offer a long-term solution to your present problems.

I am, of course, aware that it is not always easy to take the long view. There may be some people here and there who will say "the tea bushes will last as long as I do, so why bother?" Moreover, replanting on a substantial scale, even by slow degrees, calls for the maintenance of confidence in the future of the industry in the minds of those who have to find the capital. But the alternative to the long view may well be the dwindling and deterioration of a great industry, with results too disastrous to contemplate.

I would like to say a word about the responsibility which lies on all who own or control or have the management of cultivable land, whether it be under tea or any other agricultural product.

All progressive countries have come to realise, in recent years, that those who own or control or manage land are in the position of trustees of an invaluable and irreplaceable national asset. As such, they have a duty to their beneficiaries, who are their fellow citizens, to maintain intact and indeed to augment the national capital which is in their hands.

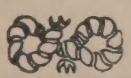
In times like these — when progress in agricultural science has been barely sufficient to keep pace with the increasing demand for food, arising from the rapid increase in the world's population, especially the East — no country can afford bad farming or tolerate inefficient or negligent farmers.

Any owner of land who merely seeks to exploit it and to snatch quick profits, who takes all and puts nothing back, is like a defaulting trustee and it is both the interest and the duty of the beneficiaries to get rid of him. Fortunately, the great majority of the tea planters of Ceylon are aware of their great responsibility and, like the farmers in the United Kingdom, have resisted the temptation to seek quick returns at the expense of the soil. The result is a magnificent industry of which this Nation should be proud.

But, where there are any land owners who squander the resources of their land and neglect their responsibility, then the modern state may find itself compelled, in order to preserve its principal and most important asset, to enforce good farming policy and practice.

And, in conclusion, may I express my pleasure that Professor MacDonald of the Ross Institute has spoken so highly of anti-malarial work and progress in sanitation on the plantations of Ceylon. For a land owner is not only trustee of his land in the interests of the nation, but trustee for the lives of the workers on his land. I am very glad to note that the vital statistics of the tea estates have always compared very favourably with those for the rest of the Island. In fostering the amenities and conditions of life for your labour force and promoting its welfare, you will reap not only the satisfaction of living in the midst of a happy and contented community, but the improvement in their health will further enhance your power to compete with producing areas in other countries.

The future holds out to you great promise and scope for your abilities. I sincerely hope that world conditions will permit you to continue in peace and prosperity, and that success will crown your deliberations today.



THE BLISTER BLIGHT CONTROL CAMPAIGN.

J. LAMB.

DIRECTOR

TEA RESEARCH INSTITUTE OF CEYLON.

The first thing I wish to say about the blister blight control campaign is that it is a planned undertaking, and I would like to remind you of the plan. When blister blight first arrived in Ceylon fears were expressed that a repetition of the coffee crash would result from the invasion. Dr. Gadd very quickly reassured you on this point and stressed the fact that, whereas the coffee leaf disease attacked mature foliage leaves, thereby destroying the livelihood of the coffee bush, blister blight only attacked the immature leaf of the tea bush, the greater part of which is normally removed by plucking. Dr. Gadd refused to make any prognosis, but warned you that the battle against blister blight would resolve into a battle for the maintenance of foliage leaf. The first tactic, which was devised by Dr. Gadd and Dr. Tubbs, was to change pruning periods so that recovery takes place in the period most unfavourable to the enemy.

It is essential constantly to bear in mind that 50% of the crop of the tea bush comes from the air, and that foliage is responsible for the absorption of the carbon dioxide which is turned into carbohydrates and other constituents of the crop. It is equally vital to recognise the fact that the carbohydrate or starch reserves upon which the bush draws to make a recovery from pruning, also are manufactured from carbon dioxide.

Next, we must examine the disposition of our defences. By the Ceylon system of bush management two leaves and a bud are harvested and a third leaf is left to mature and to provide the means for absorption of carbon dioxide. If the enemy penetrates the outer defences and gains the two leaves and a bud, no more harm is done to the bush than normally results from plucking. If blister blight gains the third leaf, the inner defences are penetrated and a seige is laid upon the bush resulting in slow starvation.

We may, therefore, call the fight against blister blight the battle for the third leaf. Generally speaking, we have won the preliminary skirmish by the dry weather pruning tactic but heavy attacks of blister blight are, in the worst affected areas, impeding the food supplies and causing malnutrition of the bushes. At the end of this S. W. monsoon many estates in the S. W. zone looked thin and ragged.

The plan of the campaign is divisible into distinct stages —

Firstly, a complete study of the nature and course of the disease which was carried out by Dr. Gadd and Mr. Loos between 1946 and 1949.

Secondly, a reconnaisance of the weak points of the enemy which was carried out last year by preliminary experiments, culminating in the Symposium at which advice from experts experienced in fighting plant diseases was obtained.

Thirdly, the planning of the attack. At this stage a report was submitted to the Tea Controller and funds obtained for the campaign. A special vote of Rs. 150,000 was made for 1950 which we understand to be the first of a four-year plan. I take this opportunity for acknowledging our appreciation of this special vote. I must also refer with appreciation to the support given by Government in agreeing to waive duties on crop protection equipment imported for the use of the Tea Industry.

Fourthly, the counter attack which was started this year and which we hope will grow in scope and intensity.

Having outlined the plan of the blister blight campaign I now wish to say that all the information we have to give you today is the result of team work amongst the whole staff of the Institute. There have been periods during the past month when almost every member of the staff has been engaged directly or indirectly upon some aspect of crop protection investigations. The work has been divided into a series of papers, as we cannot all speak together, but we have given more consideration to the best method of presentation, than to individual responsibilities for the work described.

We are confident that we have made substantial progress and acknowledge our appreciation of all the ready assistance we have received from many individuals, many estates, all agency houses, and many commercial interests. Although it is very difficult to make distinctions we feel that we should acknowledge the especially large amount of assistance we have received from Mr. B. D. Garnier, the Superintendent of Kataboola Estate, the Consolidated Estates Co., Ltd., and Messrs. George Steuart & Company in connection with three main experiments covering a total area of 406 acres of Kataboola Estate.

We do not claim to have made any fundamental scientific advance. In all essentials we have merely adopted methods used by other agriculturists for many years past. There is no novelty about the introduction of crop protection methods to the tea industry, but there are certain features which distinguish crop protection against blister blight. I think I can quite fairly say that when crop protection experts visited Ceylon last year they were all appalled by the terrain and the weather conditions as well as the necessity for repeated protective measures at intervals as close as 10 days. Had we not been spurred on by necessity, I feel we might have given the job up as hopeless. There was no alternative to spraying during rain, and a novel feature has, as a result, emerged from our work, for the success of spraying and dusting during relatively heavy downpours of rain, and the retention of fungicides on tea leaf under such conditions, is at least surprising. We are under the impression that successful protection of a crop by fungicides, under the conditions in which we have worked, is a distinct development in crop protection technique.

Perhaps a word of praise for the estate labourer would not be out of place here as the success of crop protection methods applied during rain depends on labourers who are prepared to stay on the job.

The papers to be read during the day will give you a fairly complete account of the more practical aspects of our work. We must, however, think two or three years ahead. Todays work in the laboratory may develop into small scale field trials next year and into large scale trials the year after. There is insufficient time to explain all the long term work and plans in detail, and I must now in order to complete my account of our work as a whole, resort to a condensed form of report.

1. An Engineering Department of the Institute came into being when Mr. James Landreth joined our staff in March 1950 after a short "busman's holiday" in the U.K. during which time he visited the crop protection sections of the Long Ashton Research Station, the Shell Laboratories in Amsterdam, Plant Protection Ltd., and Pest Control Ltd., as well as a member of manufacturers of crop protection equipment. Mr. Landreth also purchased precision

workshop equipment while he was in the U.K. The delivery of this equipment has unfortunately been very slow but a temporary workshop has been set up in the laboratory. A simple form of knapsack equipment designed to suit our requirements, which we hope can be produced and maintained cheaply, has already been developed. This equipment is available for inspection later in the day. A great deal of new equipment, including three machines for large scale work, is coming to the Tea Research Institute for trial. Mr. Landreth will be largely occupied with such trials in the future months.

2. Following Dr. Swarbrick's visit to Ceylon last year the Shell Company loaned us the services of Dr. Pfaeltzer from their Amsterdam laboratories. Dr. Pfaeltzer arrived in April and has carried out an intensive field trial of proprietary fungicides gathered from all over the world as well as a number of substances being developed by the Shell laboratories. 58 different fungicides in 188 different formulations were each tested on 20 bushes. A large number of control rows were dispersed over the whole area which contained 296 units covering 1½ acres.

Some of the more promising fungicides were later tested on a larger scale over a total area of 8¾ acres.

It is undesirable and even dangerous to give you any further details. I can, however, safely say that copper based fungicides are the obvious choice for present use and that the possible development of a systemic fungicide, one application of which may immunise bushes for a considerable period, is not a forlorn hope. Encouraging results have been obtained, and nothing more than that, may be said at present.

Dr. Pfaeltzer also found time to study the conditions required for the germination of blister blight spores.

We are greatly indebted to the Shell Company for their co-operation and have found Dr. Pfaeltzer a most interesting and stimulating colleague.

3. Expert help with knapsack spraying has also been available to us through the much appreciated assistance of Plant Protection Ltd. who have hired us the services of Mr. C. L. Scoles for six months. Mr. Scoles has given us valuable advice and assistance with all our spraying experiments and is also assisting us in the search for nozzles which are most suitable for spraying tea under the various conditions encountered.

4. Dr. Dike of Universal Crop Protection may now be called a regular visitor to the Tea Research Institute. Dr. Dike came out to the symposium last year, returned in May with a dusting machine, and stayed with us until August. During this period he made very considerable progress with dusting and you will hear more about this later.

Dr. Dike has just flown back to Ceylon again and I have much pleasure in welcoming him to this Conference. I hope he will give us a short address during the afternoon.

5. It is my pleasant duty to welcome Dr. Greenslade and Mr. Bals both of whom attended the symposium. Both these gentlemen have brought new machines out for trial and I hope they will tell us something about them this afternoon.

6. During the year we made a preliminary essay at training superintendents and labourers in crop protection methods. 12 superintendents concerned in our extensive experiments attended a 3 day course of lectures and practical work. 86 labourers from the same estates were trained in spray gangs.

If crop protection methods are adopted by estates we feel that superintendents' courses should be provided next year. A course for conductors and intelligent K.Ps may also be sound policy, but it will be impracticable to train large numbers of labourers. We can, however, include advice on the training of spray gangs in the courses for superintendents and conductors.

7. In order to keep all estates concerned with crop protection methods fully informed about developments, modifications, etc. we intend issuing periodical circulars to all who register their names for the purpose. *Will you please write to us if you wish to receive these circulars.*

Finally, I also warmly welcome a number of other visitors who have travelled long distances to attend the Conference. Dr. Van Emden and Dr. Van Hell have come from Indonesia, Mr. P. de Jong from the Scientific Station of the United Planters' Association of Southern India, Mr. A. Johnstone from the Department of Agriculture, Malaya, Mr. R. V. M. Jodrell of Universal Crop Protection, Ltd., from London, Mr. R. Coleman of Imperial Chemical Industries, from Madras and Mr. R. W. Thorpe, Director of Tea Estates India Ltd., from South India.

BLISTER BLIGHT - PROPRIETORS' VIEWS.

G. K. NEWTON.

Approximately one year ago I was asked by the Director of the Tea Research Institute to compile a paper setting out the views held generally by members of agency houses on the effect of blister blight on tea estates in Ceylon, as affecting costs and capital value. At that time I expressed my thanks to those gentlemen associated with agency houses who had been good enough to assist me by submitting their views and once again I would like to express my appreciation for their continued co-operation in helping me to compile this paper.

Last year I indicated the generally accepted view that blight attacks on estates up to 2,000 feet in elevation were not causing apprehension, except in small areas. The mid country zone, 2,000—3,999 feet, was one where the intensity of attacks varies very considerably between estates and even between different fields of estates according to situation in relationship to mist belts, cloud formation and rainfall intensity. The upcountry zone, being tea planted at 4,000 feet and above was considered to be the most vulnerable; these general observations once again being recorded by interested parties. Irrespective of elevation it is now a recognised fact that estates situated where rainfall is recorded and mist prevails during the north east monsoon period only are less affected than properties where rain falls and there is mist during both monsoons. Last year I referred to share values reflecting this feature, which factor has been if anything emphasised over the past twelve months' transactions.

Without exception, my advice is to the effect that crop losses cannot be calculated to any degree of accuracy in terms of poundage per acre since so many varying factors have to be taken into consideration; however, there seems to be a generally accepted view that crop losses are being sustained, estimated at 5—15%, on mid country estates, and for upcountry properties 5—20%, or perhaps more in the worst affected areas.

Another factor of a disturbing nature reported from several quarters is increased activity of meadow eel worm where blister blight is very active. Indications are that in areas where eel worms have always been present, their activity becomes intensified with blister blight attacks which reduce the general health of the bush, allowing the other pest to get a greater hold.

Probably the chief complicating factor is occasioned by the somewhat heavy flushes experienced following severe blight attacks, which, in some degree, offset the loss of crop but cannot compensate for the reduction in the physical condition of the bush. Loss of vitality appears to be taking place as the blight consistently

attacks, causing defoliation, after which reserves stored up in the plant itself have to be used in excess of normal requirements to assist in refoliation. This is an aspect I have no doubt scientists will be dealing with later, but one of serious concern to estate owners as reduction in the vigour of bushes can only lead to reduction in the value of the property itself, some of the more pessimistic being of the opinion that the worst affected estates may deteriorate to such an extent that eventually they become uneconomic units.

Preventive measures adopted so far have been to restrict pruning to within a few months of each year, whereby tea recovers in the dry weather period.

While tea planters, visiting agents and other authorities agree this practice is necessary under existing conditions, and its introduction on advice by the Tea Research Institute served a useful purpose, the sooner pruning into wet weather can be re-introduced the better.

There are many objections to pruning fields continually, cycle after cycle, into dry weather; the old programmes of pruning into the monsoon (or alternate dry and wet weather programmes) have proved their suitability by long usage.

Proprietary interests in many cases have adopted a policy of resting badly affected tea for varying periods; this seems to have done considerable good, but tea out of plucking is a charge, and not a revenue earner, being an added factor for production cost increase.

Some proprietors have already adopted the system of protecting tea recovering from pruning by the use of prophylactic sprays. Reports indicate they have had their reward. A few experimental areas where tea has been sprayed while in plucking show remarkable results of crop increase. So far, however, this has not become a general practice as the majority have been awaiting the result of experiments carried out under the guidance of the Tea Research Institute.

Later this morning we shall no doubt be given the latest information in regard to prophylactic sprays and dusts, which have been under examination by the Tea Research Institute, as well as various types of machines for use in crop protection.

If proprietary interests can be satisfied that their tea may be protected against blister attack by chemical means one immediately has to consider the cost of such projects. A number of figures for spraying tea have been produced, which seem to average between Rs. 2 and Rs. 3 per acre per spraying, depending much upon the terrain of the land and availability of water. The cost per pound must of course vary considerably, according to the yield per acre, but from a number of figures I have taken out it would seem to vary between 5 and 8 cents per pound per annum for spraying (for the vulnerable wet period of 6 months) pruned areas only.

Costs for protecting tea recovering from pruning are calculated without the requirement to recruit more labour, but when protection for the whole area is made a requirement additional labour has to be considered. I have taken out figures in very close detail in respect of this factor, to which I will not refer here as too much time will be taken up. My calculations are based on the employment of an additional 1/8th male adult per acre as a requirement for the work of spraying to be done. Spraying will be for a period of, say, 6 months only, but employment has to be found for the additional labour over the balance of the year, and the wives and children of the labourers concerned require to be employed. This requirement amounts to a somewhat formidable figure taking into consideration additional statutory requirements given under:—

(i) Medical aid.

(ii) Feeding children.

(iii) Education.

(iv) Maternity benefits.

(v) Holiday pay.

Using calculations for recently increased rates of pay, the employment of men on spraying only would amount to 17 cents per lb. The employment of these men over a whole year will amount to 21 cents per pound, and the employment of the men with their wives will amount to 30 cents over the year on estate producing 600 lbs. per acre. In addition to this, I calculate another Rs. 500 per acre as a capital requirement for the construction of additional accommodation on Government Plan No. 91.

My intention in quoting figures without allowance for protection increasing yields is to draw attention to the additional cost proprietors have to face if they wish, or find if necessary, to protect their tea for the future, and it must be borne in mind that these calculations are based on labourers' wages at existing rates. In addition to the preventive methods by spraying with machines operated by labourers, we have the alternative of the use of a dust blown out by a mechanically driven machine. Whatever method is adopted additional cost has to be faced, if crops and capital values are to be maintained for an area of 100,000 acres of Ceylon Tea estimated to be severely affected, and up to 300,000 acres less severely affected. I previously mentioned the generally accepted view that crop is being lost, and probably the last south west monsoon period has been the most severe so far.

Last year I gave Ceylon's production figures from 1944 to 1948, this year I can record 1949 and in round millions they are —

1944	—	273	millions.
1945	—	230	„
1946	—	290	„
1947	—	287	„
1948	—	296	„
1949	—	298	„

Artificial manure applications must have assisted greatly in maintaining the Island's crop level, after the arrival of blister blight in 1946, and it is interesting to note that imports of artificial manures into Ceylon were; for 1946, 1.2 million cwt., 1947, 1.3, 1948, 1.6, 1949, 1.7, and 1950, 1.6. All these artificials did not go into the tea of course, but the increase from 1947 goes to illustrate higher applications following decontrol, which might have resulted in heavier tea crops for the Island, but for the limitations of the blight.

This season there was the promise of a record output from Ceylon, production to the end of June being 173 millions, with the average monthly output of 28.8 millions. After the arrival of the south west monsoon however, crops from the blight affected areas fell off to an alarming extent, July output being 17.7 millions, August 18.4 millions, and September 18.8 millions.

During these three months on estates where the yield per acre was reduced in extreme cases on some fields to 7—10 lbs. an acre, there are records of monthly cost of production showing up to as much as Rs. 5.- per pound or more. This of course levels out over the whole year, but cannot be ignored as a cost-increasing factor.

Since the industry has been going through a period of prosperity, recent results have been favourable, and boards and proprietors have been able to set by adequate reserves as well as taking profits. Had it not been for this fortuitous circumstance I am afraid the position for many producer interests would have been entirely different.

Without doubt blister blight is affecting capital values and production costs. Some producer interests favour abstaining from chemical protection as being

only a palliative; they want their estates replanted in blight-resisting clonal material. The cost of such a project is worthy of close study before crop protection of our existing tea is rejected. Many estates have cropped tea for well over half a century where it seems doubtful if the soil can sustain replanting, without a long period of rest and building up.

Investigations into blight-resisting types have not been extensive, as the majority of working planters have their hands full with current estate affairs, without such additional work. However, where experiments are being carried out results are promising. Tea supplying by methods practised in the past has been almost entirely suspended, protection of young plants dotted about here and there being impossible in practice; where large areas have been replanted protection by spraying has been done and the supplied areas successfully established. Systematic replanting has maintained the capital value of tea properties in the past and unless it can be recommended we have another factor affecting capital values.

I know I am voicing the feelings of all those who have interests in the Industry either as agents or working planters and I say we are anxiously awaiting the pronouncements by the Tea Research Institute, which will enable those who wish to protect their tea to go ahead with programmes which have been found suitable during recent experiments carried out with the Institute's guidance.

CROP PROTECTION DURING RECOVERY FROM PRUNING.

G. B. PORTSMOUTH.

The Institute's original recommendation to estates in bad blister blight areas to adjust their pruning programmes so that recovery takes place during the driest and most mist free period of the year is now well known. From the outset it was realised that this policy of minimising the damage done by blister blight by modifying our normal agricultural practice was by no means the final answer in regard to blister blight control. Although obviously only a temporary palliative, subsequent experience has fully confirmed the soundness of this recommendation, which has almost certainly played a major part in keeping estates in economic operation in bad blister blight areas.

Unfortunately pruning into the dry weather has itself a number of disadvantages and dangers from the agricultural standpoint. Considering the disadvantages first:— Pruning into the dry weather in areas receiving both monsoons almost certainly means pruning around November/December with the consequence that a quarter or even a third of the estate is out of bearing during the quality months of March and April when highest prices should be realised. Furthermore, and this applies to all areas, recovery during the dry weather is very considerably slowed up, resulting in anything up to a complete month's crop being lost during the course of the cycle.

Most of you will doubtless think the foregoing amply justifies your reverting to your pre-blister blight pruning programmes as soon as satisfactory protection can be assured. However, I should be failing in my duty if I did not also take this opportunity of warning you of some of the actual dangers attendant on pruning into the dry weather. Too little attention has been paid in the past, in this country at any rate, to the effects of sun scorch on exposed branches. Our recent experience indicates that this danger is a very real one and, as the effects are likely to be cumulative, a marked increase in the incidence of branch canker must be anticipated if fields continue to be pruned into the dry weather. Fortunately, the danger of sun scorch damage may be minimised to some extent by protecting the frames of the pruned bushes as far as possible from the direct rays of the sun. Accordingly, I would suggest that the prunings should be piled back on top of the pruned bushes. Alternatively, manna grass or jungle loppings can be used for shade as has been the usual practice in N. India after a severe prune.

Drought by itself may also lead to dying back of branches from the pruning cut inwards and thus cause a permanent reduction in frame size. Here, of course, the usual drought precautions are all that can be done to prevent such die back. In particular it is most important that no forking is done during the dry weather, otherwise the rate of water loss from the soil may be much increased.

A further objection to dry weather recovery is the possibility of a heavy mite attack building up which may cause shedding of the newly formed leaves and thus seriously reduce the amount of blister resistant maintenance foliage available for the coming cycle.

At this stage I feel that I have said enough to convince you all of the undesirability of continuing pruning into the dry weather any longer than is strictly necessary as an anti-blister blight measure. This has been the view of this Institute for some years now with the consequence that, as the Director has already told you, we have made the problem of protecting tea recovering from pruning one of the highest priority in our experimental work. In what follows, therefore, I shall attempt to give you as much information as possible concerning our progress to-date in solving this particular problem.

Those of you who attended our Symposium on blister blight in November last year will recall that we had already reached the conclusion that spraying with a suspension of a copper fungicide in water might provide satisfactory protection. A suitable concentration appeared to be 4 oz. of "Perenox" to 10 gallons of water. It was also our opinion and that of our expert advisers, Mr. Lane of Plant Protection, Ltd., and Dr. Greenslade of Pest Control, Ltd., that low volume spraying at a rate of about 12 gallons per acre was essential if costs of protection were to be kept at an economic level. For this purpose the most satisfactory type of spraying equipment then available was generally agreed to be a battery of pressure retaining knapsack sprayers and central charge pump. Low volume nozzles were, of course, essential.

Although no field experiments on any reasonable scale had then been carried out on the protection of tea recovering from pruning during the south west monsoon, a nine acre experiment on the protection of tea recovering from pruning during the north east monsoon was actually in operation on Uda Radella Estate, Nanu Oya, at the time of our Symposium. This experiment proved very successful and as it is fully described by Mr. Loos in a *Tea Quarterly* article, I do not propose to consider it further today.

In spite of the apparent success of this Uda Radella experiment we were still uncertain whether spraying under the more difficult conditions of the south west monsoon would afford adequate protection to tea recovering from pruning. Furthermore, no valid figures regarding the cost of spraying under estate conditions were as yet available. Accordingly, early this year, plans for spraying some 200 acres of tea recovering from pruning during the south west monsoon were drawn up and an order placed with the Four Oaks Company for some 40 pressure retaining knapsacks, complete with double boom lances, and four central charge pumps. Shortly afterwards the Consolidated Estates Company Limited kindly sanctioned an experiment on 200 acres on Kataboola Group, Kotmale, for this south west monsoon. This estate was most suitable as it suffers very heavily from blister blight both during the south west and north east monsoons and offered a wide variety of terrain from the most difficult to the most favourable. The offer was enthusiastically endorsed by the Superintendent, Mr. Garnier, who has been of the very greatest assistance to us throughout the whole course of the experiment. Mr. Garnier entirely re-arranged his pruning programme so as to revert to what would have been the normal south west pruning dates and went to great pains to ensure that the necessary labour for spraying was available when required.

In an experiment of this size it is very necessary to have a responsible man on the spot to train the spray gangs, organise all the technical details and to keep complete records of costs, etc. Accordingly, Mr. N. M. Lindsay, a graduate in agriculture, was very kindly loaned to us by the Colombo Commercial Company for the duration of the experiment.

In accordance with pre-blister blight estate practice pruning started about the the middle of June and was completed by the middle of

August. Particulars of the fields pruned and the dates spraying started in each are shown in the table.

TABLE I.

KATABOOLA GROUP

200-ACRE EXPERIMENT, 1950.

Division.	Field.	Acres.	Pruning Dates.		First sprayed.
			Start.	Finish.	
Hoonoocotua	No. 1	55	12.6.50	13.7.50	14.7.50
do.	No. 2B	33	4.8.50	12.8.50	17.8.50
Top	No. 6	54½	10.7.50	3.8.50	2.8.50
Middle	No. 4	14½	10.7.50	14.8.50	2.8.50
do.	Yellabanda A	6	12.6.50	24.6.50	11.7.50
Lower	Kotmale A	16¾	12.6.50	8.7.50	12.7.50
Accrawatta	No. 2A	12¼	29.7.50	5.8.50	11.8.50
do.	No. 3	8½	15.7.50	24.7.50	3.8.50
		200¼			

Note.—Yellabanda A and Kotmale A are very steep and difficult fields.

It will be noted that in the earlier pruned fields spraying did not start till about one month from pruning. Budbreak was, however, rather earlier than this and it was soon realised that spraying should start within about a fortnight from pruning if blister blight infection of the earliest shoots was to be avoided. The principle of spraying within a fortnight of pruning was accordingly adopted for all later fields. Furthermore, although it had been the original intention to spray throughout on 7 day rounds it was decided to close up the first three rounds on all fields to 4 day intervals as far as availability of labour and equipment rendered this practicable.

By the middle of August the whole 200 acres was being sprayed and both equipment and labour was fully extended. It had originally been hoped that under very adverse weather conditions it would have been possible to postpone spraying for that day and complete the programme later in the week. This was found to be impossible in practice and it was accordingly decided to spray right through the week irrespective of weather. The weather this monsoon was particularly bad and some 72 inches of rain fell during the 4 months from July to October.

TABLE II.

KATABOOLA RAINFALL, 1950.

Month		Inches	Wet Days
July	...	20.81	30
August	...	17.04	29
September	...	22.40	22
October	...	12.39	25
Total	...	72.64	106

Although there were less wet days in September the rainfall during the early part of this month was excessively heavy. Spraying during this period did not appear to give complete protection and there was a certain amount of blister blight infection in evidence some two to three weeks later. This is now thought to be mainly due to wind drift of the spray rather than to heavy rain. Apart from this one period, spraying during rain appears to have been most successful and we have thus succeeded in initiating an entirely new principle in crop protection.

Those of you who attended our demonstration at Kataboola last month will have seen for yourselves the successful outcome of this large scale experiment. To those of you who have not been able to visit Kataboola I would merely like to quote Mr. Garnier's opinion that recovery in most of the sprayed fields is as good as it was before the advent of blister blight. (See plate).

In Kotmale A and Yellabanda A fields however, where the bushes were badly debilitated we had a very slow recovery. Slow recovery increased the difficulties of spray protection and thus increased the scope of our experiments. We, therefore, strongly recommend a period of rest *with spray protection* before pruning areas where starch reserves are low. Mr. Garnier had rested Yellabanda three times but on each occasion blister blight destroyed the new foliage of the resting bushes and annulled the benefit of the resting period.

Now as to costs, Average costs per acre spraying round, worked out up to October 31st are as shown.

TABLE III.

KATABOOLA GROUP

200-ACRE EXPERIMENT, 1950.

Division.	Field	Number of rounds up to Oct. 31st	Cost per acre per round	Normal tipping date.
			Rs.	
Hoonoocotua	No. 1	16	2.30	31.10.50
do.	No. 2B	11	1.91	30.11.50
Top	No. 6	14	2.25	31.10.50
Middle	No. 4	14	2.10	4.11.50
do.	Yellabanda A	18	2.66	30.11.50
Lower	Kotmale A	17	2.61	18.11.50
Accrawatta	No. 2A	12	2.02	23.11.50
do.	No. 3	13	2.42	6.11.50

Over the whole 200 acres the average acreage per labourer employed works out at **1.17** and the average cost per acre per round up to October 31st is **Rs. 2.26.** Assuming an average of some **16** spraying rounds over the whole area up to tipping to be sufficient, this means that it has been possible to protect tea recovering from pruning for as little as **Rs. 36.16** per acre. This figure covers all field labour employed, including kanganies, plus the cost of Perenox at 11 cents per ounce. It does not, however, include the cost of staff grade supervision. At Kataboola an estate K.P. was employed full time on supervisory duties from the start of the experiment. Later on, as the scope of the work increased, it became necessary to provide for additional supervision by stationing one of our own field attendants at Kataboola.

It will be noted that costs vary considerably from field to field, the steeper and more difficult fields costing more per acre per round.

Legend : View of Yellabanda A field taken mid-October, showing a part of the unprotected control plot at right centre. The complete destruction of all new growth by blister blight in this unprotected area is in marked contrast to the normal recovery of the sprayed bushes on the left.

As Mr. Scoles will be dealing with this subject later in the day, I do not propose to say anything further regarding supervision or other operational difficulties encountered in the course of this experiment.

Parallel with the main 200 acre experiment at Kataboola, a number of different estates in bad blister areas in several different districts agreed to co-operate with us by spraying areas of about 50 acres each of tea pruned down into the south west monsoon, Similar equipment to that at Kataboola was to be used but the conduct of the experiments was the sole responsibility of the superintendents. However, we promised to give as much assistance as possible and actually ran training courses at St. Coombs for the superintendents concerned in June and for their spraying labourers in July last.

Details of the estates taking part in these experiments are as shown.

TABLE IV.

SPRAYING EXPERIMENTS.
SOUTH WEST MONSOON 1950.

Estate.	District.	Acres.	Pruning Start.	Pruning Finish.
Agra Ouvah	Agrapatana	40	6.7.50	16. 9.50
Dessford	Nanu Oya	30	15.6.50	24. 6.50
Diyagama West	Agrapatana	37	1.7.50	24. 7.50
Frotoft	Ramboda	24	1.7.50	31. 7.50
Glasgow	Agrapatana	33	1.7.50	24. 7.50
Hope	Hewaheta	39	10.7.50	11. 8.50
Mayfield	Hatton	83	5.9.50	5.10.50
Mooloya	Hewaheta	111¼	1.6.50	13. 7.50
Pedro	Nuwara Eliya	24	15.6.50	31. 7.50
Tangakelle	Lindula	50	1.7.50	24. 8.50
Uda Radella	Nanu Oya	80	1.7.50	26. 8.50

In all cases where the experiment is sufficiently advanced there is no doubt on the part of the superintendent concerned that it has been successful from the crop protection angle. Actual costs per acre per round however vary from a minimum of Rs. 1.60 to a maximum of Rs. 4.57 depending on the estate. High cost figures resulted when the superintendents concentrated on ensuring adequate spray protection rather than on keeping costs down. I must stress that the main object of these experiments was to test the possibilities of spray protection and to elicit difficulties which might arise in normal estate adoption of crop protection methods. The very low figure of Rs. 1.60 is undoubtedly exceptional since extremely favourable weather conditions were experienced throughout on the estate concerned. In general, it would appear that a fair average for the costs incurred in these series of experiments would lie between about Rs. 2.50 and Rs. 3.00 per acre per round. **We are confident that our own figures represent a reasonable cost.**

Anyway there can be little doubt, as a result of this season's work, that spraying with a copper fungicide on 7 day rounds regardless of weather conditions, can provide satisfactory protection for tea recovering from pruning during the south west monsoon. As to whether it is an economic proposition, that is a question which I must leave you to decide for yourselves.

I have given you reliable figures for the costs at Kataboola which are most encouraging, but you must remember that these figures do not include costs of staff grade supervision nor depreciation of equipment.

In conclusion, I would like to express our sincerest thanks to all those proprietors, agency houses and superintendents who have so readily placed their acreages at our disposal and given us their whole hearted co-operation in this series of experiments.

CROP PROTECTION DURING PLUCKING.

C. A. LOOS.

Definite progress has been made with the control of blister blight as a result of our investigations into the exact nature and course of the disease. For instance the knowledge that the majority of infections take place through the upper surface of the leaf made possible the reduction of spray applications from 50 gallons and more per acre to the more economical output of 12—15 gallons.

To avoid confusing results by trials with more than one copper fungicide it was decided to confine our experimental work, in its initial stages, to one proprietary formulation — Perenox — against which other formulations may be judged when the opportunity arises. Perenox, in the experiments I shall review, was made up at the concentration of 4 ounces in 10 gallons of water; the concentration we recommend for the control of blister blight.

Before large scale experiments in the protection of tea in plucking could be planned, we were faced with two very important problems —

(a) the maximum interval between spray applications for effective control,

(b) copper residues in the manufactured tea.

To determine the answer to these problems an accurately laid out experiment, known as the St. Coombs No. 9 Field Crop Protection Experiment, was started on an area of tea pruned in December 1948. Since recovery took place during the dry weather spray protection was unnecessary after pruning. The area is divided into four blocks, each of which consists of three treatments — weekly and fortnightly sprayings with Perenox, and an unprotected plot. Each plot in the block consists of a double row of 50 bushes, on either side of which two guard rows of tea are allowed to grow up as a protection against spray drift between treatments. The four replications, which are on a randomised basis, contain 400 bushes or extend through one eighth of an acre.

The accuracy of the lay out of this experiment may be gauged from the crop returns for the first five pluckings before blister blight caused damage.

TABLE 1.

St. Coombs No. 9 Field Crop Protection Experiment.

Crop returns expressed as lbs. made tea per treatment.

Pluck No.	Unprotected plot lbs.	Weekly protected plot lbs.	Fortnightly protected plot lbs.
1	2.8	2.8	3.2
2	1.8	1.5	1.8
3	1.4	1.7	1.6
4	0.5	0.4	0.4
5	0.9	1.0	1.0
Total for 5 plucks	7.4	7.4	8.0

The experiment completes its second year in the cycle at the end of this month. Table 2 sets out the yield returns and costs of spraying for the two years under review.

TABLE 2.

St. Coombs No. 9 Field Crop Protection Experiment.

Crop returns and costs of spraying for the years 1949 & 1950.

	Yield expressed as lbs. made tea per acre			Increase in yield over unprotected plots		Total number of sprayings	
	Unprotected	Protected weekly	Protected fortnightly	Protected weekly	Protected fortnightly	Weekly	Fortnightly
1st year from Pruning (1949) 23rd May to 31st Dec.	328.8	414.4	410.0	85.2 (+26%)	81.2 (+25%)	29	15
2nd year from Pruning (1950) 1st Jany. to 11 Nov.	534.0	702.2	665.2	168.2 (+31.5%)	131.2 (+24.6%)	30	16

Although in 1949 protection at fortnightly intervals gave almost as good results as weekly protection, it has to be borne in mind that blister blight was not particularly severe in that year. Even then weekly protection of this first year field proved profitable as 85.2 lbs. of made tea per acre was obtained as the result of 29 sprayings at a cost of Rs. 65.25. In the monsoon of 1950, this year, blister blight was more severe with the result that fortnightly protection has not been as effective as weekly applications. We gained an extra crop of 168.2 lbs. made tea per acre at the cost of Rs. 67.50 for weekly protection and 131.2 lbs. at the cost of Rs. 36 when spraying was on fortnightly rounds. As no one can safely predict weather conditions or the intensity of blister blight attacks early on in the monsoon, I consider it will be playing on the safe side by fixing the spraying intervals at a suitable point between 7 and 14 days.

In the experimental area it is quite simple to point out the sprayed and unsprayed plots from the visual appearance of the bushes alone. The weekly sprayed plots show magnificient tea while the unsprayed bushes are small in comparison and carry a large amount of defoliated shoots. It is very obvious that the yielding capacity of the sprayed bushes is far above that of those which have remained unprotected.

The build up of blister blight infections on unprotected tea may be correlated with weather conditions and the intervals taken in the formation of the white sporing blister. In the last two years we started the monsoons with no apparent translucent spot infections on flush points. A translucent spot or the first visual indication of infection, as Mr. Lamb has already explained, is visible 8—10 days after the penetration into the leaf of the infection tube from a germinating spore. A further interval of 7 to 10 days elapses before the translucent spot becomes a white sporing blister from which large numbers of viable spores are freed into the air. An interval, therefore, of 18—19 days intervenes between one crop of translucent spots and the next which are the direct result of that first crop maturing to the white blister stage. An initially rapid, followed by a steady incremental build up, is shown clearly by the counts of infections on flush at the commencement of the south west monsoon this year.

TABLE 3.

St. Coombs No. 9 Field Crop Protection Experiment.

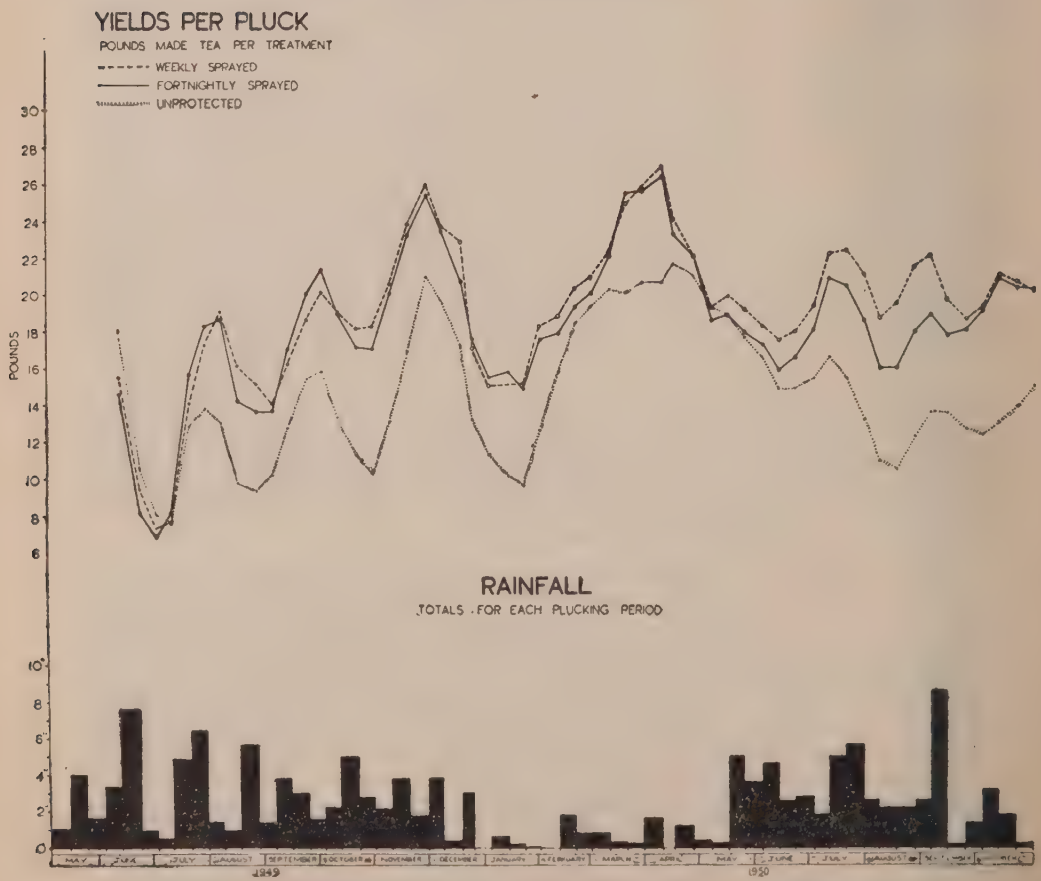
Build up of blister infections on unprotected plots.

Date of Pluck	Percentage flush infections — translucent spots.	Rainfall between plucks	Rainy days between plucks.
		inches.	
10/5/50	0	0.69	3
19/5/50	2	0.02	1
29/5/50	2	7.67	7
7/6/50	45	1.67	8
16/6/50	50	4.35	7
26/6/50	70	3.12	10
5/7/50	96	2.51	9

19/5/50 — 7/6/50 — 19 days.
7/6/50 — 26/6/50 — 19 days.

FIG. I.

WET SPRAYING OF TEA IN PLUCKING
ST. COOMBS. Nº 9 FIELD.



Legend : Graph showing yield trials for the years 1949 and 1950.

Fig. 1 shows that a period of about six weeks elapses between the start of the monsoon in May and the first evidence of crop losses. Those losses are directly attributable to the heavy spore output from the millions of blisters which mature under suitable weather and growing conditions. If one realises that a single blister may produce 2—3 million spores, the output from blisters on one acre alone is beyond comprehension. The loss of blister susceptible material by die back following stem attacks causes the reduction in the number of infective white blisters with the result that crop forges ahead again in late July and early August. That rush of crop is, however, shortlived as fresh infections and a rapid build up of a new lot of blisters gives rise to the second severe loss in crop. These two attacks coming close on each other are responsible for a reduction of flushing points and infection of young axillary buds.

With wet spraying at reasonable intervals this infection of axillary buds does not occur even though white blisters may be fairly evident in the field. This may be accounted for by the fact that most run off from the sprayed leaf surface is alone the leaf stalk or petiole and over the axillary bud which thus becomes well coated with the fungicide.

The potential cropping capacity of a tea bush depends to a great extent on its health and spread. A field which has an almost continuous cover of tea must yield far more crop than one through which a man may walk between the rows without difficulty. Yet it is possible, for a few years, to take as much crop from one as from the other. That crop from the smaller bushes is, however, at the expense of capital and the day must eventually arrive when the capital pays no more dividends. If tea culture is to continue it is essential that capital value or bush health must be conserved.

Capital depreciation is indicated from the trend of crop yields on my No. 9 field experiment. During the period December to early May blister blight on St. Coombs is at a very low level and it is then that unprotected bushes should find it possible to forge ahead and make crop while the sun shines. This does not happen. Bush spread was limited during blister attacks with the result that even under favourable growing conditions crop continued to lag behind that of areas protected during the monsoons. Weather conditions in the early part of 1950 had been suitable for heavy cropping in March and April but as you see on the graph (Fig. 1) the cropping capacity of the unprotected plots must have been seriously diminished as they were unable to support the same yield as the plots which had received spray protection in the previous year. It is too early to forecast what the yield trend will be in the 3rd year (1952) but judging from the size of the unprotected bushes it seems possible that the effect will be even more marked.

To reduce copper residues in manufactured tea to a minimum it is advisable to spray fields as soon as possible after plucking in order to allow the maximum number of days between a spray application and the subsequent pluck. The indication from the experiment I have just described is that spraying at intervals of between 7 and 14 days will give effective control of blister blight. Thus a spraying interval of 9 to 10 days based on the usual estate practice of plucking on 9 day rounds should prove satisfactory.

In 1950 it was decided to repeat this experiment on a much larger scale. Accordingly the St. Coombs No. 8 field Crop Protection experiment was commenced in May 1950 on an area pruned lightly in December 1949 and brought into tipping without spray protection. The area is divided into three plots A, B, and C, each approximately 2½ acres in extent.

It is unfortunate that we could not afford the labour and supervision to lay this large experiment down as a properly replicated field experiment. Nevertheless the plots were carefully chosen for uniformity and bush counted. The yields from each plot before blister blight attacks commenced indicated that reasonable uniformity had been achieved. Pluckings are at 9 day infervals for three consecutive plucks but every 4th pluck is on a 10 day round to avoid the extra cost of plucking on a Sunday.

Plot A.—Control. Unprotected with fungicides.

Plot B.—Spraying with Perenox was commenced on 2nd May, the day following tipping. Sprayings will continue at 9 and 10 day intervals through both monsoon periods but will cease in January when the usual dry weather sets in.

Plot C.—Sprayed as for Plot B until September 9th when spraying ceased. Crop returns from this plot show the results of protection under S. W. monsoonal conditions only.

Application rates with Perenox range between 10 and 13 gallons per acre. Severe losses in crop were evident from 14th July in the unprotected plot in comparison with the two sprayed plots B and C.

TABLE 4.

St. Coombs No. 8 Field Crop Protection Experiment.

Crop returns expressed as pounds made tea per acre for the period 14/7/50 to 8/9/50.

Plucking date.	Unprotected A. lbs.	Protected at 9-10 day intervals B. lbs.	C. lbs.	Increase of crop over unprotected plot A B. lbs.	C. lbs.
14th July	6.1	18.9	25.1	12.8	19.0
24th „	7.9	25.1	22.7	17.2	14.8
2nd Aug.	4.9	17.9	21.6	13.0	16.7
11th „	7.8	19.9	20.5	12.1	12.7
21st „	8.7	17.7	16.2	9.0	7.5
30th „	7.4	9.4	7.8	2.0	0.4
8th Sept.	11.8	14.9	14.5	3.1	2.7
Total 14/7/50 to 8/9/50	54.6	123.8	128.4	69.2	73.8

The cessation of spraying of plot C on 9th September was obviously too early. By 16th October white blisters were very evident, and crop started to decline on 25th October. On 3rd November yields from Plot C were below even that of the control plot A though 10 days later, following the effect of better growing weather, Plot C yields increased again but were still below that of the area regularly sprayed.

TABLE 5.

Crop Protection Experiment St. Coombs No. 9 Field.

The effect of cessation of spraying on 9th Sept.

Plucking dates	YIELDS EXPRESSED AS LBS. MADE TEA PER ACRE Plot A Unprotected lbs.	Plot B Sprayed every 10 days. lbs.	Plot C Sprayed every 10 days until 9/9/50 lbs.
8th Sept. '50	11.8	14.9	14.5
18th „	5.3	11.6	12.3
27th „	5.6	17.7	18.1
6th Oct.	6.9	32.0	31.0
16th „	9.8	22.9	21.3
25th „	12.9	23.0	19.3
3rd Nov.	19.0	20.9	13.8
13th „	20.4	28.4	23.3

Whether or not the effects of the cessation of spraying will continue to have an adverse effect on crops and bush health still remains to be proved. Visually plots B and C are equally good.

For the whole period under review, 19th May to 13th November 1950, crop returns for the 3 plots are set out in Table 6.

TABLE 6.

St. Coombs No. 8 Crop Protection Experiment.

Crop returns expressed as pounds made tea per acre and spray applications for the period 19/5/50 to 13/11/50.

	Crop returns. lbs.	Increase in crop over A. lbs.	No. of sprayings	Total cost of sprayings.
Plot A. Unprotected	234.5	—	0	0
Plot B. Protected every 9-10 days throughout	407.8	172.7	22	Rs. 49/50
Plot C. Protected every 9-10 days up to 9/9/50	383.7	149.2	13	,, 37/50

Many of you have seen the experimental area during the recent demonstrations on St. Coombs. To those who have not the colour slides which you will now see may give an indication of the visual difference between the sprayed and unsprayed plots. Protection has certainly given an area of tea which approximates in appearance the field we knew before blister blight commenced its ravages.

This field has given a spectacular increase in yield as a result of spraying I have explained that it is not a replicated field experiment and the fact that an 80% increase of yield has been achieved over the severe blister blight period from May to October must not be over emphasised. Spraying has actually shewn a profit. The indications are that spraying would have paid for itself even though yields and prices were much lower. The real value of this experiment, however, lies in the capital value of the protected bushes. Only a visit to the area can demonstrate this point effectively but we maintain that the principal benefit of spraying first year tea in plucking will result from the protection of the capital value of the bushes.

THE APPLICATION OF CROP PROTECTION METHODS.

PART I. — WET SPRAYING.

C. L. SCOLES.

Seconded from Plant Protection Ltd.

Introduction.

You have already heard from Mr. Lamb this morning, that as a result of this year's large scale experiments, the Tea Research Institute are now able to recommend the spraying of tea recovering from pruning and tea in plucking against blister blight.

Mr. Portsmouth has given you details of the Kataboola experiment together with basic costs, etc.

My function this morning is to endeavour to give you the benefit of our experience this year from the practical angle and I hope this will be of assistance to you in planning and organising next year's spraying programme.

My remarks will apply chiefly to tea recovering from pruning but I will deal very briefly at the end of this paper with the specific problems of tea in plucking.

Equipment.

The equipment used in this year's trials is manufactured by the Four Oaks Spraying Machine Company of Sutton Coldfield, Birmingham, and is of the battery knapsack type consisting of a charge pump and a number (usually 8—12) of pneumatic pressure retaining knapsacks.

Many of you already know this equipment but for the benefit of those who do not, I will briefly describe it.

The central charge pump is a simple combined air and water pump and services the knapsacks with both air and spray fluid. At the start of operations each knapsack is charged with air to 30 lbs. pressure, then spray fluid pumped in to bring the pressure up to 75 lbs. This gives approximately 2½ gallons of fluid. These are manufacturers recommendations but in practice we have found it more satisfactory to work on pressures of 40 to 90 lbs. which gives approximately 2¼ gallons fluid.

In the knapsack cylinder itself a rubber ball floats on the surface of the liquid, and when all the liquid is expelled, the ball seats on a valve and retains the original air pressure in the cylinder. Subsequently it is only necessary to pump in the correct quantity of spray fluid which takes about a minute, although the air pressure must be periodically "topped-up."

At the end of the day's work, each cylinder should be cleaned out and sufficient clean water pumped in, to take the air pressure directly off the rubber ball.

The advantages of this type of equipment over other knapsack sprayers, lie in the fact that labourers have both hands free of spraying purposes and that no pumping action is necessary on their part.

Each knapsack complete with equipment, weighs about 19 lbs. and with 2¼ gallons of spray fluid the total weight is approximately 42 lbs.

Generally the standard equipment used this year proved satisfactory but there are modifications which would be helpful under Ceylon conditions, and suggestions have been passed on to the manufacturers. The most important of these refers to the charge pump which has not proved very satisfactory for pumping air at upcountry elevations. This is due to the rarified atmosphere together with the fact that a combined pump can never really be efficient as an air pump. It may well be more satisfactory to have a simple water pump for spray fluid, and a car foot pump or factory compressor to provide the air.

It is advisable to pass all water through a 100 mesh sieve before mixing takes place in order to prevent nozzle blockages.

As many of you are aware efforts have been made to increase the speed of spraying by the use of a small boom attached to the end of the spraying lance, which would enable two rows of tea to be sprayed by a labourer walking between the rows. In practice, however, this modification has not proved satisfactory for two reasons:—

(1) Labourers always tended to concentrate on one row only, the spraying of the other row being left more or less to chance.

(2) The boom proved too unwieldy on the difficult terrain experienced on estates, and the quality of the work suffered.

In the circumstances we consider that in the case of tea recovering from pruning it is much more satisfactory to use a single lance which enables a labourer to spray each bush carefully.

The question of suitable nozzles is an important one but unfortunately we are not yet in a position to make definite recommendations. It is important to have a low volume nozzle in order to cut down the quantity of water to be used per acre and low volume spraying under your conditions has the further advantage that the leaf is dry in a very short time and there is less likelihood then of the copper being washed off.

This year's work has been carried out with Teejets, the type recommended for use with the boom, and which give a fine fan shaped spray. For use with the single lance however it is not perhaps the ideal nozzle and we are at present testing prototype nozzles which give a wide hollow cone type of spray. We hope that one or other of these, although necessarily of a greater output than the Teejet, will speed up the work of spraying.

Perhaps those that are interested in this question of nozzles will register their names with the Tea Research Institute and we shall be pleased to notify such people of recommendations in due course.

Organisation in the Field.

Good organisation is very important indeed, and if efficient, will materially reduce the cost per acre. The whole job should be properly planned beforehand and not just left to chance. When planning, the principle to bear in mind is that the charge pump should be kept as near the spraying labourers as possible. The time spent by labourers returning to the charge pump is all dead time and should be cut to the minimum.

Before work commences I suggest that you walk over the fields to be sprayed and plan out in your minds eye, the various positions for the charge pump and the areas, or blocks to be covered from each position. The question

of water must be taken into account when doing this, as the position of the charge pump will to a certain extent be determined by the availability of running water.

There are nearly always streams to be found in most fields and where such streams cross the paths, will be obvious charge pump points. Some portions of fields may be rather tricky and the difficulty can be met quite cheaply in various ways.

(1) Existing streams can often be diverted down field drains to points where the water is required.

(2) Containers such as 40 gallon oil drums with the tops removed, or concrete tanks, can be set into the ground beneath drains and surface water collected by means of lengths of bamboo.
In areas of reasonable rainfall you will find this most efficient. At Kataboola a number of areas were served with water by this means and in 3½ months we only once had to fill these drums by hand.

(3) In areas where spraying is being carried out from roads or where paths are good, a small two wheeled hand truck can be used for carting water. I know of one estate where such a truck was made up from scrap material for Rs. 30/-.

When water points have been fixed, pits should be dug to facilitate the collection of water, drums dug in and bamboo set in position. After the first one or two spraying rounds it may be found necessary to put in further water points, or alter the organisation somewhat in the light of experience. This can easily be done however.

Labour.

I would emphasise here that it is essential to select your most reliable labourers since it is almost impossible to check up afterwards on the quality of work and the only real criterion of efficiency is the result achieved.

It is important, as far as possible, to keep the same men on the job throughout and a little extra financial encouragement will help matters considerably as well as assist the quality of the work. Such financial encouragement can take several forms — such as paying pruners rate, a bonus on the quality of the job, or a combination of both.

Every effort should be made to make the labourers aware of the importance of their job, and to try and stimulate their interest.

That Tamil labour will react to such encouragement and propaganda, has been proved at Kataboola where the quality of work generally has been good, the daily kanaks high, and the turn out among the regular spraying labourers almost a 100 per cent despite weather conditions.

Supervision.

This question of supervision is an all important one and cannot be stressed too strongly. But this I mean, the actual field supervision, the kanganies or K.P.'s in charge of the spraying gangs. It is useful of course if an S.D. can look in every now and then and keep an eye on the work but this form of supervision is not nearly so important as having good men in the fields.

This fact was shown up clearly on one small field at Kataboola where a Kangany with a small gang was left with little supervision. The quality of the work was bad and parts of the field were quite severely infected with blister blight. The kangany concerned was admittedly a bad choice but the presence of a good K.P. would have made all the difference, and in fact this mistake was immediately corrected.

The moral of this story is that small fields should be as well supervised as large ones.

Mr. Portsmouth has given you the basic costs at Kataboola to the 31st October but at this point I would like to give you some idea of the cost of staff supervision for the same period. On this experiment the equivalent of two K.P.'s were employed and assuming that their monthly pay averaged Rs. 80/- each, the total cost in 3½ months would be Rs. 560/- or approximately **20 cents per acre per round sprayed.**

I implore you therefore to put your best men on this job. You won't regret it!

Labour Organisation.

The optimum size of a spraying gang is probably about ten spraying men, two pump men and a supervisor. One charge pump should be able to keep pace with as many as 12 spraying men but such numbers are rather a strain on the supervision. Within limits, the larger the gang, the more economical the cost per acre, since the pump men and supervisor are static, anyway, whatever the size of gang or acres sprayed per day. For this reason large fields will usually work out cheaper than small ones.

Labourers should spray two rows of tea each and on the flatter areas it will be found most convenient if the whole gang spray long rows up and down between paths or paths and boundaries, etc. On steep slopes, however, it is easier to work by blocks between field drains and one or two labourers can spray short rows within each block. With this method the amount of clambering about is reduced to a minimum and there is less physical strain on the labourers.

On exceptionally steep areas, such as we experienced on one field at Kataboola, it may be necessary for labourers to walk up first, and spray down the slope only. Apart from ease of working this also ensures that each bush is sprayed from above and that the leaves receive a top cover. This is an important point and I would stress again that bushes should be sprayed from above and not from the same level as the bush, as may happen if labourers are working up very steep slopes.

Sprayers should return independently to the charge pump for filling purposes, thus ensuring a continuous stream of men backwards and forwards and cutting waiting time at the pump to the minimum. It is also helpful if labourers are provided with sticks to mark the point at which they have left off spraying. If some such method is not adopted there is always danger of bushes and even complete rows being missed.

I always like to see two extra knapsacks with each gang which can be filled at slack times and carried by the second charge pump man to the spraying labourers working furthest from the pump. The empty container can then be brought back to the pump for refilling once more. This helps to cut down unnecessary working time by spraying labourers and to speed up the job.

Spraying Technique.

The aim of low volume spraying should be to obtain a fine even cover of spray fluid on the susceptible leaf, and not to drown the bushes. This fine cover is best obtained by holding the lance a foot or so above the bush. If the lance is held too low, a patchy cover results.

Effects of Weather.

You will hear from Dr. Haworth later today that a proportion of copper is held by a tea leaf even when sprayed under conditions of heavy rain.

That this amount of copper is effective against blister blight has been borne out in practice at Kataboola and other estates.

This is a revolutionary development in crop protection technique, and is of the utmost importance as far as the control of blister blight is concerned. If spraying had to be confined to dry weather, it would be quite impossible to carry out control measures in many areas of Ceylon and probably quite uneconomic on the remainder where the rainfall is less. As it is however we are able to recommend continuous spraying whatever the weather.

The effect of wind should be mentioned here, as high winds tend to blow the spray away before it reaches the bush, and blister infection in two trials this year was traced to this cause. Wind-drift must be counteracted by holding the lance closer to the bush and slightly windward.

Although, as I mentioned earlier, low volume nozzles should be used, they must give a forcing spray, as in the case of the Teejet. Very fine nozzles are not suitable, as the spray produced drifts badly even in light airs.

Application Recommendation.

The fungicide used in all trials this year has been Perenox and it appears that the optimum dilution is 4 ozs. to 10 gallons of water. Generally, mixing will be carried out in a 20 gallon container in whcih case 8 ozs. of the fungicide will be used to a mixing. Suitable measures to contain the correct quantity of fungicide can easily be devised.

The quantity of spray fluid to be used per acre will vary according to the state of growth of the bush. In the early stages, 12 gallons to the acre should be found sufficient to cover new growth but after 6 to 8 weeks the quantity applied should be gradually increased up to 16 or 17 gallons just before tipping.

These figures are only a guide and hard and fast rules cannot obviously be laid down because so much depends on the size of bushes and the speed of growth. The real criterion is "cover," and if the gallonage per acre is not sufficient to give this "cover," the application rate should be increased.

The first spraying should be given before any bud development is observed — normally about two weeks after pruning — and where possible it is advisable to carry out the first four rounds at four day intervals. Subsequent rounds should be at seven day intervals.

Output.

In the early stages of spraying it is quite within the powers of a labourer to spray an average of 1½ acres per day, though towards tipping this may fall to about 1¼ acres. On the basis of 1½ acres per labourer, a gang of ten spraying men will spray 15 acres per day or approximately 90 acres per week.

Tea in Plucking.

The principles outlined previously apply equally to the spraying of tea in plucking. The quantity of fungicide should again be 4 ozs. to 10 gallons of water but 12 gallons of spray fluid per acre will be sufficient to cover the plucking table. Spraying rounds can be carried out at weekly or up to 10 day intervals and should take place immediately after plucking, to ensure the minimum copper residue at the next harvest.

I would like to mention once again at this point, the question of the double boom. On flat areas and where tea is planted in the normal way, such a boom carrying two nozzles, could be used satisfactorily and will speed up the daily output. However, conditions vary so much on estates that we must necessarily be vague on this point, and can only suggest that you experiment for yourselves.

The single lance, for the reasons I mentioned earlier, is the safest and we are confining our recommendations to this.

It is obvious that on most estates it is impossible, from the labour point of view, to spray large areas of tea in plucking, but it should be quite feasible to give protection to first year fields in bearing.

Conclusion.

Agency houses, when consulted last year by the Tea Research Institute, stated that they were prepared to spend up to Rs. 60/- per acre on the protection of tea recovering from pruning, provided that satisfactory results could be assured. **The Kataboola experiment has achieved this target.** I have also seen all the smaller experiments carried out on other estates and can assure you that spray protection is fully reliable. The increase of crop resulting from the spraying of first year tea in bearing also, in my opinion, shews that spray protection is desirable.

I do, however, stress the fact that the long term effect on the health of the tea bushes, constitutes the real value of spray protection.

THE APPLICATION OF CROP PROTECTION METHODS.

PART II. DUSTING.

F. HAWORTH.

The experiments carried out at Castlereagh Estate by Dr. Dike and Mr. Baker, the Superintendent, showed that dust could be distributed satisfactorily under conditions of moderate rain and steady wind. However, it must be stated in fairness that the areas dusted were all adjoining good roads and it was reasonably easy to obtain good coverage.

Further experiments were therefore undertaken and it is the applicational aspect of these experiments that I am going to describe. On St. Coombs estate a two acre block of tea pruned in July 1950 was dusted every five days until early November when the interval between dustings was increased to seven days. The area has a cart road above it and a pathway below and with a steady south west wind, good distribution of dust was obtained by dusting from the path. However, in early September wind conditions were not favourable and it was found that dusting was best carried out from the cart road in the very early morning utilising a downward convection current instead of true wind.

This finding has been applied in the large scale experiment which was begun on the 24th October at Kataboola Estate, Kotmale. In this experiment a whole division is being dusted and the unit for application purposes is a *field*. This at once raises many difficulties since the fields are of most irregular shapes.

There has been virtually no prevailing wind at Kataboola since this experiment began and convection currents have had to be used to distribute the dust.

On paths 3-4 labourers are used to propel the machine which is mounted on a trolley, and one man operate the dusting mechanism. It has been

found that the machine operator cannot see where the dust is going and a "spotter" seems to be essential. This "spotter" conveys instructions by means of visual signals (flags have been used) to the machine operator. This system has worked quite well. On roads the machine is mounted on a small lorry and similar visual signals convey instructions to the lorry driver and the machine operator.

Starting at dawn, areas below roads and paths are dusted using the downward air current. This persists until about 6.30 a.m. when conditions become confused due to the sun rising and in general, dusting must be stopped for about an hour. After this interval the general convectional trend is up the slopes and using this air current the areas above the roads and paths are dusted. By about 10 a.m. on most days the leaves are dry and the upward convection currents are so intense that generally speaking dust cannot be applied satisfactorily.

The method just described works very well in the ideal case but many local disturbances arise and I do not think that on the average more than 75% of the bushes in a field are dusted in a given dusting round.

Under these north east conditions the mean application rate has been 10 acres/hour. I wish to make it quite clear that this figure has been calculated from dusting on 16 occasions representing a total area of some 550 acres.

An interesting observation made on one occasion was that the actual time that dust was issuing from the machine was 1.3 hours and the area covered was 30 acres. On this occasion the total time taken from the start to finish of operations was 3.5 hours. I give these figures as some indication of the amount of "dead" time which must be considered when dusting is carried out on *defined* areas.

I emphasise that my experience is only of north east monsoonal conditions but I think that some of the observations recorded will be of general interest.

CROP PROTECTION BY COPPER FUNGICIDES.

PART I. THE EFFECT OF WEATHER ON COPPER RESIDUES.

F. HAWORTH.

The problem of spray residues can be divided into two parts.

Firstly, does the fungicide remain on the leaf under adverse weather conditions ?

Secondly, what fungicidal residue, is to be expected in teas manufactured from sprayed or dusted areas ?

Normal crop protection practice is to spray under dry conditions, or to dust under moist conditions, but not in rain. However, in those areas badly affected by blister blight it is quite impossible to pick and choose these conditions during the period of the South West monsoon.

Practical experience in 1949 indicated that satisfactory protection could be given to tea in spite of continuous rainfall and it became necessary, therefore, to determine to what extent copper fungicides are retained by the tea leaf under conditions of heavy rainfall. When Dr. Dike of Universal Crop Protection came to work at the Tea Research Institute in May of this year he felt it desirable to carry out some preliminary investigations on this matter. With the assistance of Mr. Ramaswamy of the Biochemical Department he established the fact that copper fungicides are retained on tea leaf to a marked degree even when subject to heavy rainfall after application.

When I joined the staff of the Institute in August 1950 it was thought desirable that I should follow up this work using more exact methods of analysis than were employed in the preliminary experiments, definitely to establish the principles of this most important aspect of blister blight control investigations. In my first experiment pieces of cut flush were given varying protective treatments.

1 set was treated with a 12 per cent copper oxychloride dust.

1 set was treated with a 6 per cent copper oxychloride dust.

2 sets were treated with a copper oxide spray.

The two dusted sets and one of the sprayed sets were put out into moderately heavy rain immediately after treatment, the remaining set of sprayed flush being allowed to dry before being exposed. One piece of flush from each set was removed daily and the copper content of the individual leaves of each piece was determined. A note was also made of the daily rainfall. The results of this experiment are given in Table I.

TABLE I.

Copper residues on tea leaf exposed to rain.

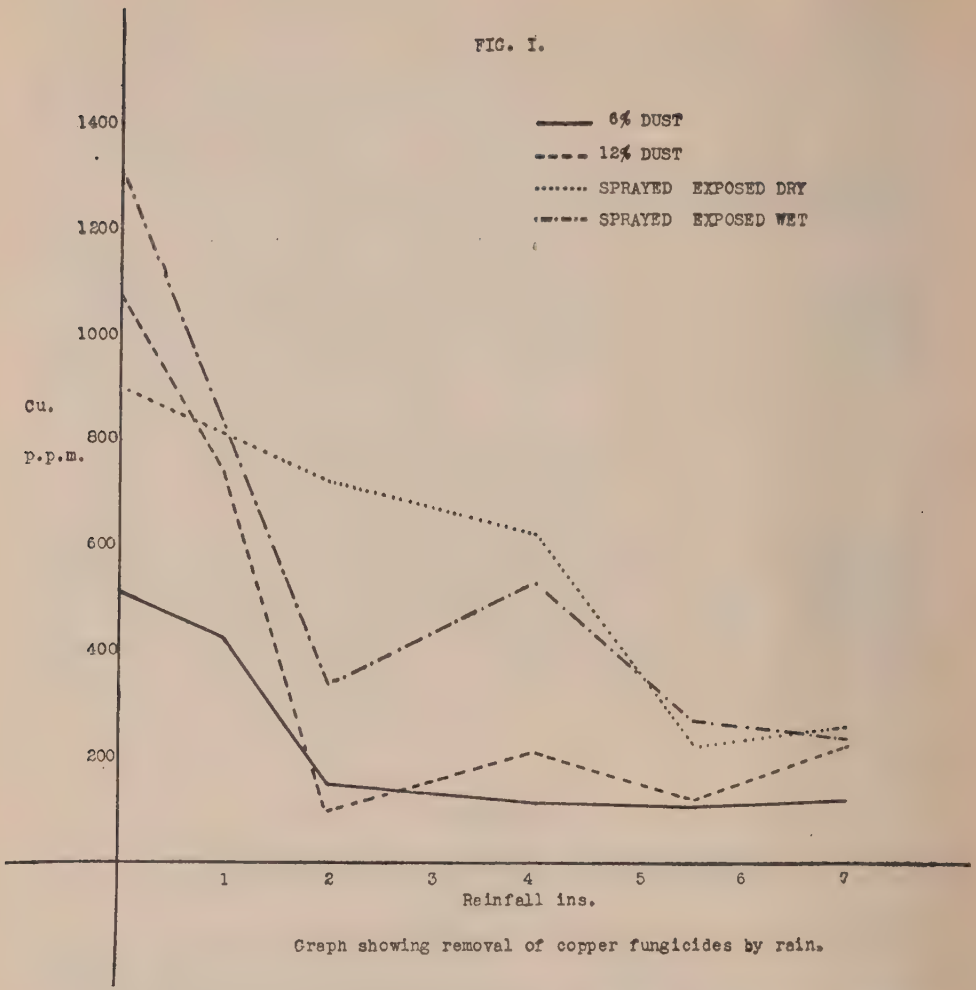
Cu. p. p. m.

Rain.	12% Dust.	6% Dust.	Sprayed and exposed wet.	Sprayed & dried before exposure.
0"	1,044	536	1,300	884
0.84"	717	403	—	—
1.99"	108	137	284	708
4.07"	196	72	492	600
5.73"	116	69	232	204
6.99"	176	88	168	200

From these figures it is evident that the fungicides applied to dry leaves were retained against the washing action of moderately heavy rain, thus verifying the earlier work of Dr. Dike on this problem.

A most interesting and important fact emerges from a more detailed study of these figures. It is best seen when the results are presented in the form of a graph. Fig. 1.

FIG I.



Graph showing removal of copper fungicides by rain.

It appears that a comparatively small amount of rain was sufficient to remove the bulk of the fungicide applied but that the remainder was held against much more prolonged washing. The reason for the retention of this small amount of fungicide is not clear.

The next step was to consider the application of the fungicides to wet leaves in rainy weather. Owing to a spell of dry weather, which intervened, rainy conditions had to be created by the use of a knapsack sprayer fitted with a fairly high output nozzle. Single bushes were sampled to determine the inherent copper content of the leaves. After being thoroughly wetted with water two bushes were sprayed in the usual way and two were dusted using a hand dustgun. Further leaf samples were taken immediately after treatment and also after the equivalent of 2½" of rain which was applied over a period of 2 hours. The results are shown in Table II. It is seen that under these conditions retention is reasonably good.

TABLE II.

Cu. in p.p.m. of dry matter.

	Dusted	Sprayed
Initial ...	30	27
Plus fungicide ...	826	1,030
After 2½" rain ...	64	88
Actual residue ...	34	61

As a final test of retention in rain, 4 bushes of Clone No. 21 were sprayed at the beginning of a deluge of rain, being sampled before spraying and 2 hours afterwards. Some 0.7" of rain fell in the 15 minutes following the application of the spray. Dusting was not attempted since it would be quite impracticable under these conditions.

Under these severe conditions no retention of fungicide was detected.

From the results of large scale spraying trials carried out at Kataboola and dusting trials at Castlereagh it seems as if the small amount of copper fungicide retained under bad weather conditions is sufficient to give a *measure* of protection against blister blight infection. However, it must be emphasised that spraying and dusting are not necessarily of equal efficacy.

Obviously with such stubborn retention of the applied fungicide the question of copper residues in the made tea is an important consideration.

At Castlereagh Estate during the last south west Monsoon, Dr. Dike started small scale dusting experiments which were continued by Mr. Baker, Superintendent of the estate, when Dr. Dike left the Island. The made teas from these trials were analysed for copper content. The results are given in Table III.

TABLE III.

Copper content of made teas from Castlereagh Dusting Experiment.

Date	Cu. p.p.m. Dry Matter.	
12.6.50	416	
27.7.50	62	
14.8.50	68	
26.8.50	64	Mean 61
29.8.50	55	
31.8.50	66	
5.9.50	52	

The first very high figure was due to dusting on the day before plucking and stands as a warning of what may happen if dusts are improperly applied.

The St. Coombs loss of crop experiment which has already been described by Mr. Loos has also provided very valuable information about the extent of the copper residue in made tea. The leaf from the control and sprayed plots has been manufactured separately and copper analysis done on each sample. The figures obtained from this experiment are shown in Table IV.

TABLE IV.

Copper contents of made teas from the St. Coombs Loss of Crop Experiment.

Cu. p.p.m. dry matter.

	Plot A.	Plot B.	Plot C.
Mean value	28	53	58
Highest figure	31	80 (Nov. 4th)	68
Lowest	24	39	40

The figure for the crop plucked on the 4th November is of special interest since virtually no rain fell between spraying and plucking. There is unfortunately no comparable figure for the copper content of the made tea from a dusted area under these dry conditions.

It may, therefore, be concluded that if spraying is carried out immediately after plucking, using the recommended amounts of fungicide, the copper content of the made tea should be less than 100 p.p.m. even under dry conditions.

Teas made from areas dusted under typical South West monsoon conditions can be expected to have copper contents below 80 p.p.m. provided that the interval between dusting and plucking is of the order of 7-8 days.

The full implications of these results will be discussed by Mr. Lamb in the next paper.

CROP PROTECTION BY COPPER FUNGICIDES.

PART II. COPPER RESIDUES IN RELATION TO QUALITY.

J. LAMB,

DIRECTOR,

TEA RESEARCH INSTITUTE OF CEYLON.

First I wish to stress that the word quality used in the title of this paper covers all the properties which make tea acceptable to buyers. Even though a tea may have all the colour, strength, pungency and flavour one could hope for, it is of low quality if it contains foreign matter or does not conform to standards set by health authorities.

It is essential to appreciate the rules and regulations which govern the sale of foodstuffs and beverages in all modern countries. A century ago the adulteration of staple foods like flour and sugar was widespread even in the United Kingdom. Public agitation led to the framing of rules and regulations. Outbreaks of poisoning have been definitely traced to the presence of minute amounts of cumulative poisons such as arsenic and lead in foods, and so, as the study of public health advances, regulations become stricter and more precise. The product of our industry only receives scant attention compared to the staple foods but it nevertheless must conform to the rules and regulations.

I strongly advise you to dismiss all irresponsible ideas about propaganda for rival beverages as nonsense. The authorities responsible for public health are not influenced by propaganda, neither do tolerances and specifications vary greatly from one country to another. Furthermore, I advise you to bear in mind the fact that public health authorities have wide powers and you have no choice; you must either conform to regulations or risk having your product condemned as unfit for human consumption.

Copper is not regarded as a poisonous metal and indeed small amounts in the diet are essential to health. Copper vessels are commonly employed for treating food products and contribute to the copper content of foods. Copper based fungicides are widely used in treating crops and many products such as canned fruits and wines contain small amounts of copper as a result of such treatment. Public health authorities have to decide to what extent such additions of copper are allowable and naturally fix limits or tolerances as they are called, at such levels as they consider to be perfectly safe.

There is no need for secrecy about all these matters. We cannot fool the analysts who examine tea or persuade authorities to allow a tolerance which they consider to be in the least degree dangerous to public health.

We can however co-operate with the authorities concerned and that I have been doing to the fullest possible extent. I am sure the whole tea industry will endorse that attitude. The natural copper content of tea leaf is normally 25 to 30 parts per million but may occasionally be as high as 60 parts per million. Any tea containing more than 60 parts per million may therefore be suspected of containing additional copper resulting from processing or from spray residues.

Some months ago the Metallic Contamination Sub-Committee of the Food and Labelling Division of the Ministry of Food wrote to the Tea Research Institute stating that they were considering limits for lead and copper in tea and asked for any information we had on this subject. I was able to report that the tea industry in Ceylon had carried out all the necessary modifications in processing, necessary to conform to requirements with regard to lead in foodstuffs, in the years 1936-1939.

With regard to copper, I reported that although brass was used in tea machinery, its contribution to the copper content of teas was very small and gave all the available information about the natural copper content of tea leaf and the content of copper in manufactured tea.

At the same time I reported our results with the control of blister blight on tea in bearing by the use of copper fungicides and expressed the hope that we could be allowed a tolerance figure to cover the additions from this source should the Industry wish to adopt crop protection measures. I also pointed out that not more than 25 per cent of the total copper in tea leaf, whether inherent or otherwise, actually passed into the liquor when tea is brewed. The total copper content of packed tea is therefore to some extent misleading. Beer, for instance, commonly contains amounts of copper, which if present in the same volume of tea liquor would correspond to 400-500 parts per million in fired tea.

Now we must for a moment consider an altogether different aspect of copper residues. Not only have we to satisfy the public health authorities, but also the tea taster. If we spray tea in bearing there is always the possibility of tainting. Our experiments have shown that the wetters and spreaders employed in fungicides are equally or even more liable to cause taints than the copper compounds. For this reason, as well as for many others, we have been careful to specify the fungicides used in our experiments. Other fungicides are most probably equally satisfactory but we cannot be sure without actual trials over prolonged periods. We are not in a position to issue any list of approved fungicides and the whole subject is one of the greatest difficulty. We have not had time to consider the possibility of prolonged field trials with all the available proprietary preparations and I am frankly doubtful whether we ever shall.

With the preparations we have mentioned in our papers we have not had any reports of taints in samples of tea containing less than 150 parts per million.

Dr. Haworth has already given you the copper contents of the teas from our field experiments. Dry periods and slow growth between the application of fungicides, and the subsequent plucking, are the source of most anxiety. Even moderate rainfall washes off excess fungicides and in the normal monsoon weather, when blight is at its worst, there should be no difficulty with the effect of copper residues on quality.

Bearing in mind all the initial uncertainties and difficulties I asked the Committee to which I have reported whether a temporary tolerance of 150 parts per million could be allowed at least until such time as the industry adapts itself to crop protection routine.

A few weeks ago I received a cable indicating that a temporary tolerance of 150 parts per million would be allowed for the United Kingdom

market on the understanding that annual progress reports would be submitted, and that constructive efforts would be made eventually to work to a lower tolerance. Immediately on receipt of this information I organised this Conference and can now assure you that there are no purely technical difficulties in protecting Ceylon tea against blister blight.

CROP PROTECTION BY MODIFIED AGRICULTURAL METHODS.

PART I. THE CONTROL OF SHADE.

T. E. WALTER.

The practice of cutting out shade trees as a blister blight control measure, which is unfortunately so widespread and which has been particularly noticeable during the recent wet weather, seems to have arisen from two misconceptions — the first based on a misunderstanding of the Institute's early advice that "shade should be controlled," and the second on the common fallacy that the yields will be increased as a result. I have heard it said that "by getting more sunshine on to my tea I can not only considerably reduce blister blight, but increase yields by as much as 150 lbs. per acre, thus deriving a double benefit by cutting out the shade." In fact the only increase derived is in the amount of soil erosion suffered, and it is unfortunately equally true that the harm done in a few days by such ill-considered destruction can only be undone over a period of years, by restoring the original stand.

Taking each of these points separately, some degree of "shade control" may be desirable where the overhead canopy is exceptionally heavy, and in areas where mist hangs about for most of the day, but it is doubtful whether the incidence of blister blight will be reduced to any material extent. Areas which are particularly liable to attack on account of the locality factors being favourable to blister blight will most certainly be badly attacked whether shade trees are present or not, and no amount of clearing will let in the sun if it is blotted out in any case by mist and clouds for weeks on end. Further, it should be pointed out that our recommendation with regard to shade control was made in the early days soon after the appearance of blister blight in this country, and in the absence of anything better this line was suggested as a palliative measure, the importance of which has since been greatly exaggerated. Control measures along other lines (by spraying and dusting) have been developed to such an extent that the contribution made by shade control in conjunction with these methods is a negligible factor.

With regard to the effect of shade trees on yield, tea is a shade-loving crop, and it is impossible to improve on the environmental factor to which it is accustomed in its natural habitat, where it grows in all pure Alibizzia forests. This hypothesis is amply borne out by the results of recent experiments at the Indian Tea Association's Research Station, Tocklai in Assam, which have shown that yields from areas under a normal shade density are in fact higher than unshaded areas at all manurial levels up to 100 lbs. nitrogen per acre. Actual figures for yield increases due to shade at various nitrogen levels are set out in the table which is reproduced here with acknowledgment to the Tocklai Research Station, to which I am much indebted for this information.

This table shows that the response to shade varies between a maximum of 19.1 per cent increase in yield for areas with no nitrogen added, and 2.5 per cent increase in yield for areas with between 60 and 90 lbs. Nitrogen per acre.*

	% Increase per acre			
	No Nitrogen.	1st 30 lbs. N.	2nd 30 lbs. N.	3rd 30 lbs. N.
Increase due to shade.	19.1	6.8	3.3	2.5

* See reference at end.

Quite apart from this effect on yields—which is likely to be considerably more marked in the low-country — shade trees have a much more important function in helping to maintain the capital value of the soil. They should, in fact, be regarded as having a far more intimate relationship with the tea than their name "shade trees" implies, and their main functions can be summed up as follows :—

1. Their roots constantly break up the sub-soil physically, thus hastening the chemical processes necessary for its weathering and subsequent replacement of lost top-soil.
2. Plant food is brought up from the sub-soil and returned to the top layers of the soil in the form of leaf droppings.
3. Wind velocity is considerably reduced.
4. Light intensity, and hence soil temperature, are reduced; thus the harmful effects of insolation on the humus content of the soil is minimised. I would add that although these effects may appear to be largely of academic interest, they are of considerable practical importance, especially in new clearings in the low-country, where a combination of high wind and overheated soil often causes collar rot on a large scale.
5. Water conservation is increased and soil erosion correspondingly reduced owing to the following :—
   (a) their canopy breaks the violence of the rain,
   (b) their roots bind the soil together, thus increasing crumb formation of the soil particles and reducing surface run-off,
   (c) the porosity of the sub-soil is increased by the roots penetrating and breaking it up,
   (d) the water holding capacity of the top-soil is greatly increased by additional humus produced by leaf fall,
   (e) evaporation of moisture is reduced not only by the overhead canopy but by the layer of dead leaves on the ground.

These factors are of prime importance on the steep slopes typical of most up-country tea districts, where soil and water conservation measures are obviously essential if it is desired to prevent the loss of the thin layer of top soil on which is based such a large proportion of the country's economy, and to minimise the perennial danger of floods in the lower reaches of the rivers.

What then is recommended in regard to shade trees and how can these recommendations be correlated with "shade control" for blister blight purposes? These can be summed up as follows :—

1. *Control of Shade.*—The only method of effecting shade control that is permissible on any grounds whatsoever, is by lopping (large Albizzias are a different problem and will be dealt with shortly). Lopping should, of course, be done as far as possible just before the monsoon, so that the loppings can be forked in with manure at the most effective time and so that shade during the early part of the monsoon is at its minimum. Comparatively few estates lop

their grevilleas but observations show that this is quite feasible; it should not, however, be done at less than 15-20 feet from the ground.

2. *Cutting down and replacement of old Albizzias.*—The huge old specimens of *Albizzia moluccana* common in all the mid and upcountry tea districts must be regarded as a separate problem, since they have obviously outgrown their usefulness and must come out. In the first place they should of course never have been allowed to reach these gigantic proportions, but that is by the way. There are, however, (as always) several right and wrong ways of dealing with them but undoubtedly the most wrong of all is to cut them all out at once. Unfortunately this is the method usually adopted, and it is common to see whole "forests" of old albizzias all ringed at the same time, their vast gaunt skeleton presenting a most pitiful appearance; the practice is not, however, condemned for reasons of appearance, but on more solid sylvicultural and agricultural grounds.

The two basic principles on which the growing of *Albizzia moluccana* in tea estates depend should be the following:—

(i) a 10-year rotation (approximately).

(ii) an *un*even-aged stand.

A 10-year rotation is of course desirable as being the most economic, since the trees when 10 years old will provide timber of sufficient size for utilization in tea chests without being so excessively large as to cause widespread damage to the tea on felling. An uneven-aged stand is essential if it is desired to avoid getting into the same awkward situation every ten years which an even-aged stand inevitably causes, the wrong method of clear felling will then presumably again be adopted and any given area is thus perpetually in a vicious circle in which it has either by comparison to much shade (when the trees are all old) or too little shade (when the trees are young), and supplies of timber are intermittent and irregular. By adopting the nearest approximation to the natural selection sylvicultural system, however, a continuous supply of timber for tea chests is assured, besides controlled even shade and maximum soil protection. Thus, estates which have removed all their shade trees and now intend replanting with Albizzias are advised to make out a replanting programme in which each year the *whole* estate is planted to a proportion of the eventual stand, which should be complete and ready for removal of 1/10th of the trees in ten years time; estates with a good cover of albizzias which are now at, or approaching, the most economical size are advised to break up these even-aged stands gradually over a period of years and replant each year so as to form an un-even-aged stand. A further sound modification is to avoid as far as possible having large stands of the same species.

In conclusion, I would add that the principles I have outlined for the growing of *Albizzia moluccana* are equally applicable to other species of shade trees, except of course that the rotation has to be adjusted for each species according to its rate of growth and eventual size.

REFERENCE.

Indian Tea Association Scientific Department, Tocklai Experimental Station. Quarterly Report for first Quarter ending March, 1950 (p. 4).

CROP PROTECTION BY MODIFIED AGRICULTURAL METHODS.

PART II. THE KATABOOLA LOSS OF CROP EXPERIMENT

C. A. LOOS.

The knowledge that old fully expanded tea leaves are immune to blister blight infection suggests a form of agricultural control for tea in plucking with resort to spray protection. As Mr. Portsmouth has already told you it is possible, even under the severest weather conditions, by employing spray protection, to build healthy pre-tipping growth which will remain blister free throughout the rest of the cycle. Once that pre-tipping growth has been formed, blister blight susceptible material, that is to say the crop, will develop above the tipping level.

When the disease is very prevalent the third leaf on plucking shoot is usually so badly damaged that it is of no use to the bush. Therefore, with the recognised standard of good plucking, this is the principal leaf on which sporing blisters develop. In fact the build up of blister blight under monsoonal conditions, and the serious loss of crop such a build up entails, may be attributed to the generally approved standard of plucking to a bud and two leaves, leaving one full leaf above the fish leaf for the development of maintenance foliage.

Two forms of agricultural control have been suggested by this Institute for tea in plucking. They are :—

(1) Shortening of the plucking rounds,

(2) Hard or fish leaf plucking.

To determine whether fish leaf plucking and plucking on closer rounds are effective in reducing the ravages of blister blight an experiment was laid out on Kataboola Group. We are indebted to the Management of the Consolidated Estates Company and Mr. Garnier, the Superintendent, for the facilities provided and for so generously meeting the costs of the experiment. Thanks are also due to Mr. Peter Armstrong for supervising the plucking and the collection of the experimental data.

The experimental area, which is subject to severe blister blight attacks, consists of five plots, each one fifth of an acre in extent, pruned in December 1949, tipped at 7" and brought into plucking on 5th June, 1950. It was not possible to commence experimental recordings until 24th July, by which time the plots had already suffered severely from blister damage. Plot treatments were as follows :—

Plot 1. Unprotected with fungicides.

Plucked at 10 day intervals, taking a bud and 2 fully opened leaves, leaving one leaf above the fish leaf unplucked. This plot gives the yield under normal estate practice.

Plot 2. Protected at weekly intervals with Perenox, at a concentration of 4 ounces in 10 gallons water, at an application rate of 15 gallons per acre,

Plucked similarly to Plot No. 1. Yield figures correspond as nearly as possible to returns that may be expected in the absence of blister blight, since spraying on 7 day rounds affords almost complete protection.

Plot 3. Protected at 10 day intervals with Perenox at the same concentration and application rate as for plot 2. Spraying was done immediately following plucking. Plucked similarly to plots 1 and 2. Yields from this plot represent the returns under the usual wet spraying routine.

Plot 4. Unprotected. Plucked at weekly intervals to the fish leaf. Only shoots which have developed a bud and 2 fully opened leaves above the fish leaf were removed.

Plot 5. Unprotected. Normal estate plucking of 2 opened leaves and a bud above a third leaf. Plucking rounds were, however, closed up to 7 days.

Yields and other data for the period 24th July to 30th October are set out in Table I.

TABLE I.

Kataboola Loss of Crop Experiment. Period 24-7-50 to 30-10-50.

Plot No.	Treatment	Yields expressed as made tea per acre. lbs.	Crop returns in comparison with Plot No. 1. lbs.	No. of spray applications.	Approximate cost of spraying.
1	*Unprotected.* Normal plucking at 10 day intervals.	148	—	—	—
2	*Protected weekly.* Normal plucking at 10 day intervals.	174	+26	15	Rs. 37-50
3	*Protected every 10 days.* Normal plucking at 10 day intervals.	159	+11	11	Rs. 27-50
4	*Unprotected.* Plucked to fish on 7 day rounds.	179	+31	0	Nil
5	*Unprotected.* Normal plucking on 7 day rounds	137	−11	0	Nil

The fish leaf plucked area is now being rested with spray protection so as to form new healthy maintenance leaf above which normal plucking will continue until the next S.W. monsoon in May 1951. The period of resting will probably be 6—8 weeks, but it may be reduced if another blister blight attack develops as spray protection is not very efficient on a thick mass of new foliage.

For the five months period under review the plot plucked to the fish leaf gave an increase of 5 lbs. made tea per acre above the weekly sprayed plot. In comparison with what is likely to be the normal estate protective

practice of 10 day spraying rounds fish leaf plucking showed an increase in yield of 20 lbs. made tea per acre.

It is very likely that the crop returns for plot 3 (sprayed every 10 days) will catch up or exceed that of the hard plucked area when the latter is rested. To offset this, however, the cost of about 25 spraying at 10 day intervals during the monsoonal period May to December as compared with only 6 — 8 sprayings during the resting period on the hard plucked area must be taken into consideration.

The closing up of rounds, while continuing normal plucking, appears to be entirely ineffective as an anti-blister blight measure and, as shown by the returns from plot 5, actually increases the amount of crop lost. However, when making the original recommendation to close pluck we were careful to point out that it applied to conditions of leaf attack only. During most of the course of this experiment severe stem attacks were continually experienced with the consequence that suitable conditions for this form of agricultural control to prove its worth did not occur. The value of fish leaf plucking during conditions of severe stem attack does not however appear to be in doubt.

We therefore suggest that you experiment with fish leaf plucking during blister blight attacks as an alternative to spray protection. We must, however, insist that the resting period with spray protection is essential. This spray protection must also be commenced three weeks before plucking is stopped in order to give protection right from the formation of bud initials.

Ordinary estate practice has shewn that it is useless to attempt to switch over direct from fish leaf to normal plucking as pluckers cannot be persuaded to stop stripping. The only way to break the stripping routine is to keep the pluckers out of the field for a time.

Preliminary experiments by Mr. Garnier have indicated that resting should be followed by one normal round to harvest all 2 leaves and a bud above full leaves. A skilled gang should be put into the field to break back so as to leave one full leaf above the original plucking table.

CROP PROTECTION BY MODIFIED AGRICULTURAL METHODS.

PART III. GENERAL CONSIDERATIONS.

G. B. PORTSMOUTH.

As I have already told you this morning, one of the outstanding examples of crop protection by modification of existing agricultural methods was undoubtedly our recommendation to estates in bad blister blight areas to adjust their pruning programmes so that recovery took place during the driest and most mist-free period of the year.

Mention of this recommendation naturally leads on to the subject of the type of pruning that should be adopted in the face of the blister blight menace. For my part I am completely convinced that a fairly light type of pruning is much the best in our present circumstances. Many of you will have visited "The Loss of Crop Experiment" on St. Coombs and I think you will agree that the bushes there have recovered extremely well. This field was given a comparatively light prune in December 1949, with almost no cleaning out. All fringe branches were, of course, left.

In my opinion cleaning out is entirely undesirable in the present state of much of our up-country bushes and, owing to the Tamil labourers fondness for the knife, merely leads to an undue number of branches being removed from the centre of the bush. In fact I have been into pruning fields where it has been easy to put my hat, and it's quite a big one, down in the centres of many of the bushes without covering a single point. This vacant area must inevitably lead to the production of hollow bushes and consequent loss of crop. In any case there appears little need to worry about cleaning out twigs. Those which are too weak will die anyway, while the stronger ones will thicken up and form useful frame branches before the next pruning. Some cleaning out will probably be necessary after a cycle or two but this operation can well be deferred until we have restored our debilitated frames and have developed wood fit to prune on.

At the present time there is an imperative need to increase the size of our bushes and restore that continuous cover of tea, which I am credibly informed, once characterised the upcountry plantations. Blister blight has undoubtedly done its share in debilitating our bushes and starch deficiency is now of common occurrence at quite high elevations. However, I am not prepared to accept the contention that blister blight is solely responsible for the greatly reduced size of many of our bushes today. Too hard clean pruning in the past has undoubtedly done its bit in bringing about the present sorry state of affairs. When I see an upcountry field pruned in this matter today, I am forcibly reminded of the serried ranks of gravestones in a cemetary and, gentlemen, the comparison is not altogether an inapt one, since if this wanton destruction of valuable frame wood is persisted in, many of the victims will indeed soon be dead.

Well, let us leave the dead to bury their dead and pass on to the subject of tipping. As you are all aware it is the leaf, and only the leaf, that is responsible for the manufacture of carbohydrates and all those other elaborate organic compounds which go to maintain the plant body and provide the material for fresh growth. The early provision of an adequate canopy of healthy maintenance foliage is thus of paramount importance if our bushes are to be able to withstand repeated blister blight attacks and still retain sufficient vigour to give us crop when the incidence of blister blight subsides. One of the best ways to obtain a good canopy of blister resistant maintenance foliage would obviously seem to be to tip high. However, a single high tipping generally results in a "leggy" type of bush and does not seem to give the same number of plucking points as a normal tipping. This procedure may therefore be expected to lead to loss of crop during the cycle. One way to overcome this difficulty would seem to be to tip in two stages at two different levels. Accordingly, with the co-operation of Mr. Garnier, we are proposing to carry out a small scale tipping experiment on Kataboola at the conclusion of the main 200 acre spraying experiment. The treatments to be compared include :—

(1) Tipping once at 4"
(2) Tipping once at 8"
(3) Tipping once at 12"
(4) Tipping twice at 4" and 8".
(5) Tipping twice at 6" and 12".

It is hoped that as a result of this experiment it will soon be possible to make definite recommendations on this somewhat controversial subject.

If the best results are to be obtained from improvement in either our pruning or tipping technique, then protection against blister blight with a copper fungicide is obviously desirable. This morning I left you with the question as to whether spray protection during recovery from pruning was an economic proposition or not? To my mind there can be only one answer to this question. In areas badly affected by blister blight it cannot be anything else but economic. In giving you this answer I do not necessarily mean to imply that the cost of such protection will always be met out of increases in current revenue. What I do mean, however, is that, in the more badly affected areas, if crop protection methods are not introduced, the bushes will continue to deteriorate and their capital value will be seriously reduced.

There is nothing novel in an agricultural industry finding it necessary to make annual provision for the cost of crop protection. On the figures quoted earlier today the tea industry is still comparatively fortunate in this respect. In this connection I would like to remind you that some 50 per cent of the cost of production of apples in England is accounted for by crop protection.

There is, of course, another solution to this problem of continuing deterioration in badly affected areas. This is replanting with high yielding blister blight resistant clonal material. The Institute is strongly in favour of this policy and a start has already been made at St. Coombs by clearing an area of four acres of old tea for replanting in 1951 and 1952. In addition an initial programme has already been drawn up in which it is proposed that some 60 acres, or approximately one fifth of our tea acreage, will be replanted over the next ten years. There are many good clones now available on estates and I see no reason why the replanting of a percentage of their acreage every year should not become a matter of normal policy for estates in the badly affected areas.

Finally a word or two about "hard" or fish leaf plucking. As you know this has been the recommended practice for some time past during periods of

severe stem attack. That this method of plucking not only reduces the incidence of blister blight infection very markedly but also increases the yield is very apparent from another small scale experiment carried out at Kataboola this year. Here an acre of tea in one of the worst blister blight areas, last pruned in November 1949, and tipped at 12" in April this year, was continuously hard plucked on 10 day rounds from the beginning of June until the end of October. Over this 5 month period this plot has yielded some 241 lbs. per acre as compared with the estate average, for tea in plucking only, of 181 lbs. per acre.

An integral part of this recommendation, however, is that the bushes must be rested for several rounds as soon as the severity of the attack has declined. Accordingly the plot is being rested from the 31st October onwards until such time as additional maintenance foliage has been put on This is most important as continued fish-leaf plucking will inevitably result in deterioration of the bush and consequent decline in yield. This is well brought out in the results from one of the long term field experiments on St. Coombs. Here fish-leaf plucking over a 3 year cycle resulted in an increase in yield of 476 lbs. per acre. However, when normal plucking was resumed in the following cycle, the plots previously fish-leaf plucked showed a drop in yield of some 581 lbs. per acre as compared with plots plucked normally in both cycles. Thus the increased crop obtained during the first cycle by fish-leaf plucking has been more than swallowed up by the loss sustained in the second cycle. The deterioration produced by a lengthy period of fish-leaf plucking has thus been proved to persist for years afterwards.

In conclusion let me paraphrase the old latin tag "*mens sana in corpore sano.*" This may be very freely translated as "*a healthy bush in healthy soil.*" Keep your soil in good heart by giving it all the humus forming material in the shape of green manure, compost, etc., that it requires, apply the right quantities of artificial fertiliser, and you will have gone a long way towards producing vigorous healthy bushes which can stand up to the ravages of a disease such as blister blight.

CROP PROTECTION BY WET SPRAYING COMPARED WITH CROP PROTECTION BY DUSTING

J. LAMB.

DIRECTOR,

TEA RESEARCH INSTITUTE OF CEYLON.

Before I attempt to sum up the relative merits of spraying and dusting as methods of protecting tea against blister blight attack I must explain why it was considered necessary to raise this issue at the Conference.

At the Symposium held in November, 1949, expert opinion tended towards the conclusion that knapsack spraying was the only immediately practical method of blister blight control but necessity for the development of machines suited to our conditions and capable of treating large areas quickly and cheaply was strongly stressed.

Mr. Loos reported successful control with one proprietary make of dust but its cost prohibited its use for controlling blister blight.

Consequently the Tea Research Institute has concentrated on the immediate development of knapsack spraying and has also founded an Engineering Section for the purpose of studying the possibilities for developing machinery for crop protection.

Dr. Dike, Dr. Greenslade, and Mr. Bals have all borne our problems in mind, and have now all returned to Ceylon with what we hope will be solutions or substantial contributions to the solution of our problems. Dr. Dike left Ceylon after the Symposium with the idea that dusting offered one of the best chances of a solution to mechanised methods of protection. He returned in May with a prototype machine which could project either dust or spray and cause them to travel considerable distances with the aid of wind currents. He also brought five tons of dusts of improved formulation containing several different concentrations of copper. These dusts were of a type which could be produced at a reasonable cost, provided that the lower concentrations of copper proved to be sufficient to exercise control of blister blight.

With the very willing co-operation of Mr. V. C. Baker of Castlereagh Estate and Mr. James MacMahon of Mattakelle Estate and the kind permission of the Directors of the two companies concerned, we were able to arrange facilities for Dr. Dike's experiments. We were also able to give Dr. Dike laboratory facilities and assistance for a study of the distribution of copper fungicide in his experimental areas.

Dr. Dike made rapid and substantial progress with dusting and we organised a demonstration on Castlereagh Estate in August. Many planters and visiting agents were sufficiently impressed by this demonstration to place orders with Universal Crop Protection for Whirlwind Dusting Machines and 2

per cent Cuprosana Dust. Others have asked our advice about whether to dust or to spray and I am therefore obliged to give our complete impartial views on the two methods, at this stage of our proceedings.

I particularly stress the point that a Research Institute responsible to an industry can only advise on a basis of available facts. These facts are normally gathered by its own staff officers and carefully checked and cross checked before publication. Perhaps we are slow and cumbersome but at least we are sure of our ground. Individual estates may assess the possibilities of any method, machine, or material, and decide that chances are favourable for success. Such procedure is nevertheless a gamble. We are normally bound to base published advice on facts.

To individuals we may give an opinion as distinct from advice and suggest that they take chances. If things go wrong then any harm done is on a limited scale. To an industry where the consequences of bad advice are unlimited we can only advice on a basis of fully established facts. I therefore ask you to take my statements to follow as you would take the summing up of a case in a court of law. In this case, only established facts are accepted as admissible evidence. Circumstantial evidence and expert opinion are rejected. When I refer to a specific product it is because that product was actually used and does not mean that other proprietory fungicides would not have proved equally satisfactory. When I say that success is not proven it does not infer failure.

In other words, I shall not draw any inferences express any opinions, but simply state plain facts in unequivocal terms.

WET SPRAYING. /

Wet spraying with Perenox has proved to be completely successful in protecting tea recovering from pruning under a wide range of terrain and climatic conditions. It has also proved completely successful in protecting first year tea in bearing for two successive years on the Tea Research Institute's own estate. Reports from other estates confirm our findings. There is no evidence to the contrary.

Wet spraying can be accurately controlled by reasonable supervision with good conductors provided the superintendent of the estate is well instructed and the labour and supervisors are properly trained. It does not interfere with plucking routine.

Wet spraying involves a relatively heavy demand on labour. One man has been required for every 7 acres protected.

The cost of spraying pruned tea or tea in bearing has been approximately the same. Mr. Portsmouth has already given you details and told you that the cost per acre per round on Kataboola Estate averaged Rs. 2.46 per acre per round.

Pruning on Kataboola Estate started in July and finished in August. The season was a bad one and recovery was relatively slow. An average of 16 spraying rounds was sufficient to afford protection from pruning to tipping and so the average working cost of spray protection from pruning to tipping approximated to **Rs. 40 per acre.** 16 spraying rounds gave satisfactory protection to first year fields on St. Coombs at the same cost.

At the present price of the Four Oaks Battery Knapsack Equipment, capital costs taking the life of the equipment at a conservative estimate of 4 years, amounts to **Rs. 20 per acre per annum.**

The total cost of spraying per acre per annum for protecting areas pruned from June onwards and for first year fields under S.W. monsoonal conditions in 1950 may therefore be taken as **Rs. 60** and a very high degree of protection is attainable.

DUSTING.

Evidence is entirely restricted to results with the products of Universal Crop Protection Limited, namely The Whirlwind Dusting Machine and Cuprosana Dust. The first experiments on a limited scale commenced in June 1950.

From the preliminary experiments carried out on Castlereagh Estate in the Hatton district, between June and August 1950, it is possible to state that:—

> With a steady S.W. wind, overcast skies with or without rainfall of the lighter type experienced in the S.W. monsoon, it is possible to distribute the copper compounds contained in the fungicide over a wide radius downwind from the dusting machine. It is not possible to define the word "wide" except to say that it was favourably regarded from the practical point of view. Over the areas of tea in bearing, treated at weekly intervals, a marked degree of bud and stem protection was observed. The conditions of the experiments were so uncontrolled that it was not possible definitely to attribute any increase of yield to the treatment. The figures obtained by plucking the dusted and surrounding undusted areas separately, even when critically examined, supported the contention that the dust was exercising control. The quantity of dust available was not sufficient for a prolonged or large scale trial but for several weeks after dusting ceased, the superintendent and members of the Tea Research Institute staff could distinguish between the dusted and undusted areas.

2% Cuprosana Dust was selected for further trial by the Tea Research Institute and 12 tons were imported for further trials on 200 acres of Kataboola Estate from mid-October onwards. The weather improved from the time the experiment started and it is not possible to observe any effects of the treatment at the present moment.

Conditions for dusting during the N.E. monsoon season on Kataboola Estate are more difficult than they were on Castlereagh Estate during the S.W. monsoon. It has only been possible to work to our satisfaction between 5 a.m. and 10 a.m. and to cover certain areas remote from roads and paths has proved impossible on some occasions. The roads and paths on Kataboola are above average standards in all respects.

All the plucking programmes for the 200 acre area were altered to give a maximum interval between dusting and plucking. Dusting on Castlereagh was carried out at 7 day intervals and we do not know whether 10 day intervals will be satisfactory from the point of view of protection. If a shorter interval than 10 days is proved to be necessary then plucking rounds will have to be reduced accordingly as we cannot approve of dusting immediately before plucking as will occur if plucking rounds are at 10 days and dusting rounds at 7 days.

Over a period of 28 days large scale operation an average of 3 labourers per day have been employed.

The cost of application has worked out at approximately 40 cents per acre per round including all accountable costs except the costs of supervision which has so far been carried out by a member of the staff.

In this period the average rate of working including loading, unloading and path work has been **10 acres per hour.**

The amount of dust used has worked out to be between 6 and 10 lbs. per acre. The aim has been to use 10 lbs. per acre and is based on results at Castlereagh Estate and the fact that we are working on a 10 day round. There is no evidence that this is the correct amount to use. The dust delivered at

the dusting machine has cost approximately 30 cents per lb. At the rate of 10 lbs. per acre we arrive at a total cost of Rs. 3-40 per acre.

Since the cost of application includes provision for depreciation of the dusting machine at 25 per cent per annum we can make a tentative comparison with the cost of wet spraying on a basis of 16 rounds per season and we arrive at a figure of **Rs. 54/-**. This figure must be taken as a bare minimum and does not include any provision for supervision.

If 10 lbs. per acre of dust applied at 10 day intervals proves sufficient to control blister blight on tea in plucking the cost of wet spraying and of dusting will be of the same order.

The present 200 acre experiment will be continued until the dry weather sets in. A further large scale experiment during the S.W. monsoon season of 1951 is essential before we can assess the efficiency of dusting as compared to spraying.

With regard to dust protection of tea recovering from pruning we have few facts to offer. Two acres of St. Coombs tea pruned at the end of July was successfully protected by dusting with 6 per cent dust, which was the only concentration available at that time, by application of 10 lbs. per acre every four days from two weeks, after pruning until November and at 7 day intervals after November.

Under typical S.W. monsoon conditions with a steady wind a good distribution of dust over the pruned area could be assured. Under N.E monsoon conditions the dusting of even this small area, which was a long narrow strip between a road and a path, gave difficulty on some occasions. This experiment has demonstrated that complete protection of tea recovering from pruning by 6 per cent dust is possible.

Other experiments have shewn that, if one round of spraying is missed or is badly applied during the early stage of recovery from pruning, the effects are disastrous.

Before taking large scale risks with dusting pruned tea we must ascertain the extent of well defined areas over which dust may be evenly distributed during S.W. monsoon conditions, whether a concentration of 2 per cent copper in the dust is sufficient and whether longer intervals between application, or shorter intervals and lower rates of application will ensure complete protection.

I repeat that we cannot take large scale risks with dusting tea recovering from pruning until more evidence is available.

THE DISCUSSION ON THESE PAPERS WILL APPEAR IN VOLUME XXII, PART I, 1951.

BLISTER BLIGHT

TEA QUARTERLY, VOL: XIX, 1947

INTERIM INDEX OF SUBJECTS DISCUSSED IN RELATION TO BLISTER BLIGHT